PSYCHOLOGY

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THE·PEOPLE'S·BOOKS

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FOREWORD

In this little book the attention of the reader will be directed mainly towards the study of experiences —their analysis, description, classification, and connections. The aim of this branch of psychological science is to show that experience is at least a part of a closed system—analogous to that of chemistry. Our scientific insight must necessarily first touch the simpler forms of experience with which we are directly acquainted, although there may be others of indefinitely greater or less complexity than these. Just so has our scientific insight into the material world developed. When the peculiar nature of the system of experience has been discovered, we shall have a more adequate understanding of its connection with the material system upon which we find it is in part dependent.

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PSYCHOLOGY

INTRODUCTION

PSYCHOLOGY is the scientific study of the nature and course of experience. Experience means all mental states such as emotions, thoughts, memories, perceptions, and sensations. Not the world of matter in motion, nor the world of abstractions like mathematical truth, but only the world of the individual consciousness, its elements, compounds, and processes, gives psychology name and aim.

Mind and body, as we know them, are closely bound together. The occurrence and change of our experiences is largely determined by the effect of impressions, coming from without and within the body, upon our sense-organs and the nerves connected with them. Observation of external objects gives food for thought; and thought, feeling, and will, in their turn, affect the body by the movements and expressions they evoke. But for these connections between body and mind it would be quite impossible to study experience adequately. For only in so far as we can stimulate sense-organs as we please, can we regulate the occurrence of mental states; and we could have no knowledge of other minds unless they expressed themselves in movements, including words. Moreover, our whole aim in education and art is to cultivate certain states of mind and to bring them to complete expression. These practical and theoretical interests extend psychology beyond the study of the nature and course

of experience alone, and urge it to consider also its natural conditions and its means of expression.

The methods of psychology are, in principle, the same as those of other sciences. It starts with what knowledge of experience the chances of daily life and casual observation provide; and by analysis and description, classification and synthesis, it tries to explain the complex in terms of the simple. But its progress has been seriously delayed for two reasons.

1. Much time has been lost in determining what the type of the science should be. Many have been attracted by the simplicity of geometry, a peculiar feature of which is that every definition is a law to all that follows; it can be extended by other clauses or by variant cases, but never contradicted. All the objects and processes of geometrical study are partially, if not wholly, prescribed by the mind. But when we are dealing with real objects of any kind, we can never be sure that they are not very much more complicated than we may at any time suppose, and that we have not overlooked many of their properties and functions. In fact our definitions may be beside the mark altogether; for these are never a law to real objects. Definitions do not here prescribe, they announce. In psychology we must therefore examine many similar objects and events, so that their similarities and differences may strike us more forcibly. To this end special methods of examination, of variation, and of multiplication of cases—especially those of experiment—have to be devised.

2. Again, if psychology is to be nourished by experimental observation, the nature of the physical stimulus and of the sense-organ, nerve, and brain the stimulus plays upon, must be thoroughly understood, lest they be confused with the action and interaction of experiences themselves. Only thus can we know, for any given experiment, whether we have varied a physical, a physiological, or a mental factor. For this knowledge, however, psychology had to wait until the sciences of physics and physiology were sufficiently developed.

And so we find among the pioneers of the experimental method in psychology Weber, an anatomist; Fechner, a physicist; and Wundt, at first professor of physiology.

The inspection of experience is a form of perception and is commonly called introspection in order to distinguish it from the perception upon which the physical sciences build—the inspection of objects which exist independently of the observing mind. The word introspection means a "looking inwards." As applied to the observation of experiences, it suggests that in order to notice the objects of the physical sciences we must look outwards. This suggestion is in many respects quite valid; it is, for example, comparatively seldom that a physical object of study lies inside the body, and we usually feel that we direct our gaze from ourselves outwards upon the objects around us. On the other hand, we do not locate our thoughts and feelings where their objects may be; we distinguish their place roughly, if at all, by saying they are in our mind or in our head. We speak, accordingly, of looking inwards to find them. Such distinctions are, in their own way, perfectly just and proper.

But we must be cautious in their interpretation. A distant mountain looks small to the eye, although we all know that it is really no smaller when we are far from it than when we are near to it. Hence it is not the mountain that changes in size, but only its appearance to us, or its effect upon our vision. What this effect is at any one moment depends upon many things —distance, atmosphere, eyesight, attentiveness, and the like—so that it will necessarily vary from person to person. It is the effect of the mountain upon visual and other mental processes, and so constitutes a part of experience.

The distinction between things and experiences can also be stated in the following way. The mountain is composed of rock, and it is covered with earth, grass, and trees; it is traversed by many streams of water, and shelters many beasts, birds, and insects; its surface

reflects the ether-vibrations of the sun (colour), its valleys and trees make eddies and torrents in the currents of air which pour over it (sound), its rock bears incalculable stresses (hardness), conducts heat well (feels cold), and so on. We learn of all these things by our experiences of colour, sound, and the rest. But these, on the contrary, neither vibrate, nor bear stresses, nor conduct heat. When we ask why a particular sensation of colour or sound is felt at a certain moment and for a certain time and changes to another thereafter, or when we simply ask "What is that?" we are trying to find out something about some object that is not itself our experience. Such an object we may know, hear, see, feel, &c., but it is not itself our knowledge, hearing, seeing, or feelings; these are experiences.

If you ask me "What is a grape-fruit?" I may describe it in words, or show a picture or a sample of it. In each case I say, as it were: judge what it is by the effects of words, picture, or sample, upon your experience; and you do so without questioning my method. If you ask what is knowledge, colour, hearing, sweetness, pleasantness, I can again only produce a sample-object, a picture, a set of words; but now I must say—if I am as sure of my procedure as I am in dealing with the grape-fruit—what you experience as the effect of my words or picture is knowledge, or colour, or pleasantness. We are, therefore, immediately acquainted with experience or with the objects of introspection. All other objects are objects of indirect acquaintance, or, better, are objects of knowledge.

Sometimes it is asserted that in introspection experience is never actually before us; it has already just passed away and must be recalled; introspection is therefore retrospection, or a looking backwards. But this is an exaggerated and mistaken view. Any simple experience that lasts for some time, *e.g.* sensation, can, for all intents and purposes, be inspected while it lasts. The inspection made is, of course, evoked by the sensation of an instant ago, preceding immediately the process of inspection itself; so, also, the mountain I observe is

the mountain of an instant ago; the sun is the sun of five minutes ago. When, however, an experience is of such a nature that it only occurs if a fairly complex group or series of other experiences is aroused, then we may have to retrospect; and sometimes, in order to have these experiences, we must follow up intentions which for the moment prevent us from observing with full attention. So must also every student of physics who has to carry out (without the aid of machinery) a long event requiring observation. He must either perform the experiment first and then immediately observe by recalling it, or invent a machine which will carry it out, and, if possible, also register the process automatically for him. He will then study the register and from it try to complete his direct, fragmentary observations of the course of events. There are machines like the cinematograph and the gramophone which will evoke experiences automatically; and there are machines which will register the effects of experiences automatically. But a machine will no more collect experiences than it will collect physical events; our immediate knowledge of certain experiences must, therefore, be completed by a study of the effects registered. In psychology, as elsewhere, this indirect method of procedure must always be used with great caution.

Summarising the preceding we may say that introspection is very often the direct inspection and perception of experience, whereby its different elements and their aspects are classified, tabulated, and compared. When we have to deal with complex experiences or trains of experiences, we must often reconstruct them gradually in repeated trials by memory, and if we fancy our memories may deceive us, try to register their simplest or most distinct effects, and by a study of these ensure a better and fuller remembrance and description of them.

But we are concerned in psychology not only with our own experiences, but with those of others as well. We wish to discover the experiences of all minds and

the laws which govern them, as well as the differences between minds. Here we are faced with a new difficulty. For we can only obtain a knowledge of the experience of others by means of its physical effects—movements, gestures, or words. Special devices of mind and body have been developed in man and the higher animals for the communication of experiences from one to the other individual. Not very much is known about these. But, for the purposes of science, it is convenient and temporarily sufficient to suppose that, when we read the record of any sequence of experiences, we consider what kind of experiences would find the same or similar expression in ourselves. We can, then, understand that the more the expressions of any creature resemble our own, the surer will be our estimate of its experience; while the less the similarity between its expressions and ours, the weaker will our inference be. This is the reason why the study of the minds of children, insane persons, and animals, progresses so slowly. For its completion a highly developed science of the introspecting mind is needed, as well as the most careful experimental analysis of the impressions which are capable of evoking movements from other minds, so that we may be able to transfer to these minds the experiences which in us accompany the simplest sequences of impressions and movements, and so to reconstruct their experiences. Genetic methods, involving the observation of the time and manner of first appearance of any given response to an impression, must also be adopted.

If the experiences of adults are to be carefully observed, it is evident that some persons must have the leisure and the special training necessary for the purpose. Of course an effort will be made to include in our list of observers as many different kinds of minds as possible; but certain observers will inevitably stand forth as the best. These expert observers will themselves usually be trained psychologists. The incompetence of the average observer in dealing with problems relating to the nature of thought, or to the connection between

simultaneous or immediately successive experiences, or to the varieties and affinities of feeling is already keenly felt. The evidence of a few specialised observers is gladly preferred. This preference should not, however, tempt us to dispense with the usual experimental procedure and the usual precautions against biassed judgment. The rôle of experimenter should be given to one person and that of observer to another; and everything should be done to keep the latter in ignorance of the plan and purpose of the experiments and of the general trend of his observations. Where there is reason to fear the bias of a local doctrine, a sincere effort should be made to obtain observers from other schools of psychology. Otherwise we shall readily fall under the suspicion of wishing to maintain a particular theory at the expense of the truth.

Although psychology needs to take account of the connection between body and mind, yet within the positive sciences it is generally recognised that body and mind are inexplicable in terms of one another. The material world can be understood quantitatively as a system of matter and energy. Any qualitative differences which this system may contain lie beyond the range of our positive knowledge, so that even for the relation of the complex to the simple in this realm only quantitative expressions can be obtained. The spiritual world, on the other hand, can be formulated as a system of units which differ from one another in several qualitative aspects. All statements regarding the relation between the complex and the simple must here be expressed in qualitative terms. If there are any quantitative relations at all, it would seem that the number of spiritual units which is at any one time under direct inspection, is so very limited that it is hardly possible to obtain any definite and general quantitative statements about them. To try to reduce qualitative differences or relations to quantitative terms is, of course, absurd. Where we are dealing with qualitative units and not with groups of individuals, the use

of quantitative expressions of their differences can be justified only by convention and utility.

Apart, therefore, from certain more or less probable, systematic considerations of a philosophic nature, we know only that certain units or processes of mind are dependent for their occurrence upon the occurrence of certain units or processes of matter, and vice versa. In so far as these material units are multiplied, there will also be a certain multiplication or extension of the qualitative units of mind they evoke. Thus we obtain a very rough and restricted parallelism between the two systems. If we do not know the creative source of our spiritual units, we can at least look for a provocative material companion for each, in some hope of finding one. But it would be folly to point to a complicated brain-process as explanation of some complicated, and as yet inexplicable, mental process. Nor can we imagine we advance knowledge by "explaining" the peculiarities of our experiences in terms of the muscular movements they evoke. It is very important to discover the bodily antecedents, accompaniments, and consequences of mental processes, but they are no explanation thereof. Complex processes in each sphere can be explained only in terms of its own units or elements. These we must take as given or created in the form beyond which we are unable to reduce them. We may also ascribe to them all those properties or powers which we can identify in them by inspection, aided by an examination of the regularities of their behaviour in, or contribution to, complex processes. These units and their properties will, then, form our basis of explanation, which should be such that we can thoroughly accept the effect after consideration of the nature of the combining unitary causes. If things become too complicated for this ideal completeness of explanation, we must be content to state our knowledge as at least a rule of dependence of one process upon another, in the same way as we state our knowledge of the dependence of the mind upon the body.

There are many motives which will always lead men to put the highest demands upon the science of psychology, no matter how difficult it may be to satisfy them. For one thing, the mind is the instrument of whatever translucent rationality our range of sciences may anywhere hold. And it is not likely that the tool will be incommensurate with its own performance. If ideas are so inevitably bound up with one another that we can work out from given premises to a distant, secure conclusion, we may safely maintain that the mental states by which we think out this conclusion are bound to one another by as firm a cement as are the ideas they convey to us. We do not found our logic upon physiological tests of nerve and muscle; nor are we likely to base our psychology finally upon physiological explanations. If so much can be guaranteed, we shall certainly never lack the motive to strive to establish it firmly. For the vastest interests are involved. If we can be stirred by the hope of discovering the history and destiny of matter, we shall be far more deeply moved when the first promise of certainty and unanimity regarding the constitution of mind, its history, and its destiny are given by psychological science. Men have continually sprung to conclusions regarding these things. And where they can do so, there seems no sufficient reason to believe that by patient research and strenuous theory they will not also shape a path to certainty which can be trodden by all who care to follow.

CHAPTER I

THE ELEMENTS OF SENSORY EXPERIENCE

THE study of experience must begin with the description and classification of the simplest possible parts of its material. This is not so easy a task as it may seem. For how shall we tell one another what mental states we are classifying, unless we can point them out to each other; and how shall we do so, unless we have already classified them?

The escape from this difficulty lies in the fact that certain experiences follow immediately and regularly upon the stimulation of sense-organs, such as the eye and the ear. These experiences are called sensations, and the simplest, irreducible forms of them are the elements of experience. There are many different kinds of sensation, each of which is connected with a particular group of sense-organs. A sense-organ is a receiver specially adapted to one kind of stimulus and hardly sensitive to any other. We are equipped with receivers for all the chief kinds of physical energy except electricity, so that we can take direct notice of, and, if necessary, respond to almost any change in our surroundings. Let us now review rapidly the chief classes of sensation.

The simplest and most primitive sensations are those evoked by stimulation of the skin and viscera. There are four chief kinds: touch or pressure, cold, warmth, and pain. It can easily be shown that particular points of the skin are specially sensitive to one of these four sensations, while the spaces between the points are much less sensitive. The blunt end of a cool lead-pencil drawn slowly over the surface of the skin will

serve to stimulate a few of the cold spots. Special sense-organs for each sensation lie presumably under these points, but they are so small and so generally scattered that even their microscopic differentiation is not easy. The most obvious are the touch organs at the root of each hair, and, on hairless surfaces, certain corpuscles called Meissner's. The two rarer sensations of tickle and itch are probably complications or modifications of those of pressure and pain.

Tastes might almost be classed with the cutaneous sensations. They are of four kinds: sweet, sour, salt, and bitter, if we neglect the doubtful alkaline and metallic tastes. To obtain pure taste-sensations smells must be carefully excluded by stoppage of the nose, for taste and smell are usually closely interwoven or fused with one another.

Of smells there seem to be innumerable varieties. No satisfactory classification or arrangement of them has yet been made. Some persons are congenitally insensitive to certain smells, *e.g.* vanilla, violets, and mignonette. Different smells sometimes compensate or obliterate one another; and the nose, when fatigued with one odour, is often thereby rendered for a time insensitive to certain others.

Sounds may be divided into two classes—tones and noises. Tones vary from one another in pitch, in regard to which they can be arranged in a simple series leading from lowest to highest. The limits of this series are rather hard to fix, and vary from person to person and with age. The lowest tone lies about one octave below the lowest tone of the pianoforte (*ca.* 16 vibrations per second), and the highest about five octaves above the high soprano C (*ca.* 20,000 vibrations per second). "A noise may be said to be a tone whose pitch is not yet audible, because it has lasted less than the time of two vibrations, or a complex sound of many pitches which make each other indistinguishable to the unaided attention." In every noise there are tones; these can be easily distinguished if a series of similar noises is produced, *e.g.* by tapping the succes-

sive posts of a fence or paling. Many tones, especially those of neighbouring pitch, together make a noise. This is more difficult to prove by ordinary means, but may be demonstrated after a fashion by pressing down many keys of the piano with the flat side of a book.

The most pleasant or musical sounds are those whose pitch is most readily distinguishable. But none of them are perfectly pure; they all contain many partial tones, whose pitches stand in certain, more or less harmonic, relationships to the fundamental component of the tone, which gives it its pitch-name. The sequence and strength of the partials of a tone differ with the instrument which emits the tone. Vowel-sounds vary in the same way; the peculiar resonance chamber formed by the mouth for each vowel introduces into it a component that remains constant, whatever may be the tone produced by the voice in uttering the vowel. This characteristic partial tone may be detected by the fact that, where the voice-tone and the vowel-tone coincide, there the sound produced will be smoothest. For this reason it is so easy to sing certain vowels to certain tones. It is only in virtue of these partial tones that we are able to recognise voices, vowels, and musical instruments by ear.

A complete survey of our colour sensations is given in the so-called colour-body, in which the colours are arranged on the basis of their resemblance to one another. Colours which show a progressive loss of resemblance to any colour arbitrarily chosen as starting-point and an increasing resemblance to some other colour, are laid along a straight line; when a resemblance to a third colour appears the direction of the line must be changed. On this plan the body represented in Fig. 1 must result, if grey is represented in it only once. The most essential difference between colours, their hue or quality, is here represented by the angular relation of any position in the figure to a constant diameter of it, *e.g.* red-green. The saturation of colours is represented by their distance from the line joining white, grey, and black in any direction perpendicular to it. The colours most satu-

rated or freest from admixture of white, such as are those given in the spectrum, are found round the outside of the figure. The brightness of a colour is indicated by the height of the above perpendicular in the white-grey-black line. Thus yellow is a brighter colour than blue, as is also indicated by the depression of the figure at the blue corner towards the black apex.

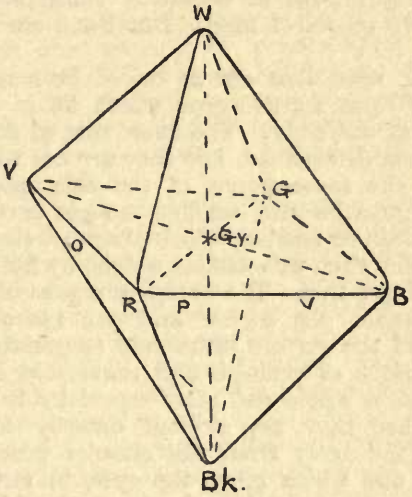


FIG. 1.

R=Red, O=Orange, Y=Yellow, G=Green, B=Blue, V=Violet, P=Purple, W=White, Gy.=Grey, Bk.=Black.

The most prominent colours of the figure are those which stand at the corners—white and black, blue and yellow, red and green.

These three pairs of colours also come into prominence by reason of the fact that some persons, known as colour-blind, are congenitally insensitive to the specific differences between red, green, and grey, while others fail to distinguish any one colour from any other, except in so far as these are of varying brightness or belong to the black-grey-white series. A form of colour-blindness

occurs in the normal eye, which fails to distinguish the colours of the yellow-blue series until they have been brought from the side a certain distance towards the point it is looking at. Colours of the red-green series have to be brought still farther forwards to be distinguishable as other than members of the black-white series.

These five groups of sensation constitute the traditional five senses of man. But there are still a few more.

Articular sensations are so called because they are dependent upon sense-organs which lie in or around the joints of the body. The exact seat of these organs has not been determined, but they are not to be identified with the sense-organs of the skin and muscles. From the muscles and tendons we get certain sensations of strain or tension, which are most clearly before the attention when we estimate weight by lifting objects with the finger-tips. The complex organs of the semicircular canals, the utricle and the saccule, in the labyrinth of the ear are ultimately responsible for certain sensations of position and movement relating to the body as a whole and more especially to the head. But whether they are evoked directly from these organs or indirectly from the muscles which balance the trunk and which move the eyes, in virtue of the reflex nervous connections between the labyrinthine organs and these muscles, is at present a matter of dispute.

Finally, there is a crowd of less varied, though practically very important sensations, such as hunger, thirst, nausea, &c. The sense-organs of these sensations are sometimes called proprioceptive, because they respond specially to states of the body itself, in distinction to exteroceptive organs, which are specially adapted to forces acting on the body from without.

The facts we have so briefly reviewed, along with many other details too numerous to mention, may be used in two different interests—physiological and

psychological. The result of the former is a body of knowledge regarding the existence, nature, position, and manner of functioning of the sense-organs and other more or less definite nervous units. In the final statement of this knowledge no reference whatever need be made to the related experiences from which it may have been, partially or wholly, derived; it must, therefore, be evident that no addition to our knowledge of the essential nature of experience or its laws can result from the pursuit of physiological interests, however important and fascinating they may be in themselves. The student of psychology must indeed follow them up with considerable devotion in order the more clearly to define his own. But he must keep them strictly on one side.

The interest of psychology in sensation centres round their essential properties or aspects, of which at least six are distinguishable. They are commonly known as the attributes and fall into two groups—quality and intensity form the one; the other contains two parallel pairs, extensity and order or local sign, duration and place in time. Cold, warmth, sound, and colour, for example, differ in quality. Two sensations, alike in all other respects, *e.g.* two tones of the same pitch from one instrument, may differ in intensity. Sensations have extensity in so far as they are spread out like the cutaneous and visual sensations, or massive and voluminous like auditory and muscular sensations. The smallest obtainable cutaneous or visual sensation is always extensive; it is never the smallest conceivable area of sensation; it is not a point in the mathematical sense. The smallest obtainable area of warmth is larger than that of cold, cold than that of touch, and touch than that of pain. The lower tones and the articular sensations from large joints are much more massive and bulky than high tones and sensations from the joints of the fingers. But although two sensations be of the same quality, intensity, and extensity, they may still be distinguishable, as are touches from the tips of the two index-fingers. They are commonly

said to differ in "local sign"; the writer prefers to say they differ in "order," because it seems to him proper and profitable to class differences of pitch along with them. That is to say, the tones C and D are alike in being sounds, but they differ in a way that is comparable with the difference between tactual sensations from two neighbouring fingers. It is so important to emphasise this parallelism that it is well to avoid at this point any reference to the fact that touches and sights form space (hence the term "local sign"), whereas tones of different pitch do not.

Finally, there are those immediately recognisable differences denoted by the word "duration." Sensations may differ merely because one lasts longer than another; thus do the sounds represented by crotchet and quaver differ. But tones of the same duration, alike in every other respect, may still differ in position in time, or because one comes third in a series and the other first; they may be distinguishable only because of this difference, and are then felt to be separated by a certain time-interval, as two lights or two tones are separated by a certain spatial interval. All these attributes are characteristics of experiences of which we are immediately aware, whether we know that the physical process which evokes them is intense, extended, here or there, first or second, or not. In fact, the physical ideas of intensity, extensity, &c., are notions which we derive ultimately from these attributes of experience, and not vice versa.

Psychology has been at great pains to devise and elaborate methods for comparing sensations with one another in respect of these differences, in order to see how far our power of discrimination extends, and how keen and regular it is, as judged by the average differences in stimuli necessary to evoke sensations just perceptibly different from one another. These methods are called psychophysical, because they aim at correlating psychical with physical differences. Their greatest student was G. T. Fechner (1801–1887), who took up and greatly advanced work begun and formu-

lated by E. H. Weber (1795–1878) in a law best known as Weber's law. Fechner hoped by his work to create a science of psychophysics, which would study the relations between body and mind in general. Weber's law says that the increase of stimulus necessary to produce a just perceptible difference in sensation is always a certain ratio of the original stimulus. Thus, if the addition of one gram to a weight of 40 grams resting on the hand can just be felt, an addition to 80 grams would be felt only if it amounted to 2 grams.

Fechner attempted to deduce from such facts that a geometrical series of differences in stimuli produced an arithmetical series of differences in sensation, or that the sensation differs in proportion to the logarithm of the stimulus. Such a statement involves two assumptions: (1) that the difference indicated by the words "just perceptible difference" is a real increment and is always equal, no matter whether the point of departure of the difference lie high or low in the scale of sensation; (2) that, when the stimulus is increased, the sensation is also increased, whether we can detect the difference in the latter or not. To make his law express a general relation between body and mind, Fechner had also to assume (3) that the reduction of geometrical to arithmetical differences was not due to some physiological cause, but expressed a law of connection between mind and the bodily processes immediately subservient to it.

The first of these assumptions is unjustifiable, until we can find some proper pattern for it within the range of experiences which we can easily observe, *e.g.* in the relation between any derived experience and the elementary experiences which "produce" it. Just so does the physicist legitimately transfer notions derived from the observation of the behaviour of large bodies which interact in a system to his hypothetical elementary bodies. In the second assumption we might substitute a variation of sensation for increase of sensation; but not even then can we say that the assumption has yet been definitely proved, although a vigorous attempt

has been made to do so. And the third assumption is surely the least probable of theories. Besides, some differences, *e.g.* those of pitch, do not follow Weber's law at all; and, in fact, all aspects of sensation show so many minor deviations from the rule that now no importance is attached even to the possibility of such a central law. Much more interest is taken in the factors which produce a deviation from any established correlation between any bodily processes and any mental processes, whether this agrees with Weber's law or not. And the psychologist is concerned with these things only in so far as they complete his knowledge of the possible variations of experience and help to indicate factors which may lead to the discovery of hitherto undetected experiences, their range of variations, and their connections.

CHAPTER II

THE MODES OF SENSORY EXPERIENCE

In the preceding chapter we reviewed the results of the analysis of sensations into their simplest parts and the methods of studying their attributes. But our sensory experience seems usually to contain much more than masses of more or less variable elements. We are immediately aware of the motion of things and of their distance from one another and from ourselves. We can, for example, detect the movement of a limb when it jerks, and even when we lie in the dark cabin of a ship we can easily distinguish the pitch from the roll. We feel motion, and we feel distance or depth, just as we feel quality or intensity. Besides, the range and delicacy of our sensitivity to these complex sensory states can be gauged with the help of the psychophysical methods. We can easily find out how much farther one thing must be from a third than another if the difference of their distances is to be just perceptible. Our next task, therefore, is to describe, to classify, and, if possible, to explain, these new modes of sensory experience.

The most obvious of them are motion and distance, which both occur in connection with several senses and in various forms; depth-distance and apparent size in vision; and in the sense of sound, melody, interval, tonality (sense of key), and our awareness of the position of a source of sound. A few modes, such as distance and depth, are evidently closely related to one another in character, the latter being merely an extension of the former into a third dimension. And this relation seems to extend to their basis in the primitive attributes of sensation as well; for both distance and depth appear

to be founded upon localisation, or ultimately upon the attribute of order. A group of cases of parallel nature is found in melody, interval, and tonality; for there is a clear psychical analogy between motion and distance, on the one hand, and certain aspects of melody and interval on the other. And if depth is an extension of distance, tonality seems to be an extension or system of intervals. The connection between apparent size and primitive extensity need not be emphasised. Thus arises the question whether all these modes of sensory experience are not really derivatives of the primary attributes of the elements. Their dependence upon these elements is certain, for they never occur alone—without the occurrence of two or more elementary sensations which they serve to unify and enrich. There seems to be no other source for them but these attributes which they resemble.

If the complex modes are indeed derived from elementary attributes by the unification or integration of their differences, two probable principles of integration may be enunciated forthwith.

In the one we acknowledge that the mode which results from the integration of an attribute must bear an immediate introspective resemblance to it. This principle has been long in dispute amongst psychologists. Some have held that such states as localisation and the estimation of distance were not the product of an attribute of position native to the elements of sensation (nativistic theory), but were derived from differences between them in respect of quality, intensity, or the like, which became the signs of place or distance on the basis of habitual association (genetic theory of space). Some forms of this theory may have been satisfactory, so far as they could show for each variation in the derived state an unambiguous complex of sensory data of an elementary kind. So much, indeed, any theory must do that is to be considered possible. But every form of the genetic theory must find itself unable to account for the peculiar product which results from the integration postulated. For how should differences of quality or

intensity, or any mixture of these, come to look like differences of place? These peculiar new differences of appearance can only be won by the development of a native attribute through the process of integration.

The other principle of integration is based upon the very natural expectation that the results of integration of the same attribute in different senses will be of parallel character. The peculiarities of the mode of motion in vision, which are to some extent known, should also be found in those states of the senses of touch, articular sensation, and sound, which are of similar introspective character or are derived from the same primitive attribute. We cannot expect to verify them in those senses in which the attribute in question is so unvaried as to be hardly detectable by introspection at all. But it may very well happen that a study of a well-developed form of integration in one sense will help to throw light on an ill-developed form of the same integration in another sense. And study of the integrations into which certain obscure sensations enter may also serve to reveal to us attributes in them which introspection alone can hardly detect.

All typical modes of experience must, to some extent at least, arise spontaneously or automatically, and independently of such processes as will, attention, inference, proof, or the like. Once they have occurred their signs or criteria can be established for indirect use. But unless our minds recognised, or thought, or felt spontaneously, we could never even begin to collect tests for the recurrence of experiences, or for the truth or falsehood of asserted relations, or for the justification of beauty. Nothing but the direct insight of experience can set the mind the larger task of extending that insight to the uttermost bounds of reason. Nor can anything else justify that extension. This is a truth of the greatest importance and of the widest validity; it holds in every region of experience, be it sensory, rational, æsthetic, religious, or what not.

The two new modes of sensory experience most easily

studied are motion and distance. Both occur in each of several senses—touch, articular sensation, vision, and hearing; both are introspectively allied to the primitive attribute of order; and both can be produced experimentally by the suitable arrangement of sensations of any one of those senses which show distinct differences of order.

When neighbouring or, within certain limits, separate sense-organs of the same kind are stimulated successively, they evoke sensations which differ at least in respect of order, and these integrate to form motion. These sensations must follow each other within a certain range of time intervals; otherwise they will be either simultaneous or disconnected, and no motion will ensue. This is an example of the general rule that all perception of change in experience, and, therefore, all experiences built upon differences of experiences, are limited to a certain range of rates of change. A tone, for example, can be raised—for an observer who does not possess absolute ear or the ability to name the pitch of any given tone—through a whole octave without any change being detected, if the change is made slowly enough. Similarly, no melody could be formed by changes so slow as this.

No moving object, then, is required for the production of motion. If a series of small electric lamps are lit momentarily in succession, the first light will appear to move from one end of the series continuously to the other if the lights stand at the proper distance from one another and appear at the proper rate of succession. This is the principle upon which motion is reproduced in the cinematograph. There single pictures of not too different phases of a movement, the intervening phases being omitted, following each other at a certain rate, produce the impression of more or less continuous motion. If the interval of time or space between the lights is increased beyond these critical points the motion will no longer be continuous, but will seem jerky or even discontinuous. At higher rates and smaller distances several lights will be seen moving at once.

In sound the correlative of visual motion is melody, in so far as that is a unity and progression of pitch. When a series of tones of neighbouring pitch are played, we can observe all the phenomena shown with the lamps —continuity of progression at a certain rate, jerkiness or discontinuity with slower rates, while with higher rates several tones are heard together in simultaneous progression. We cease to feel continuity of pitch or progression from one tone to another when, *e.g.*, the interval of an octave or more is introduced into a melody. Melody, in the popular sense of the word, has, of course, other characteristics than that of more or less continuous progression of pitch. It may be quick or slow, grave or gay, lusty or sentimental. But these aspects of it do not concern us here.

In distinction from motion, distance is not restricted to any range of differences of order, but only to a relatively large range of time intervals, including simultaneity. Tone intervals can, *e.g.*, easily be recognised, both when the tones are sounded together and when one occurs a few seconds after the other. The direction of a distance or interval can only be recognised when the distance is not among the smallest possible, so that the experiences of distance and of direction are not identical. In the sense of touch, finally, appreciation of distance is very much finer in its successive than in its simultaneous form. A great deal of elaborate experimental work has been done in the attempt to fix the lowest limits for the discrimination of two points touched on the skin, and for the discrimination of distance, direction, extents of distance, and the like. Such lowest limits are generally called thresholds, because at the point fixed the experience first enters the mind, as it were. Physiological theories have also been devised to explain many results which seem to have no foundation in psychological causes.

What, now, is the nature of the relation between motion or distance and the sensations from which they are integrated ? It is important to notice, first, that these modes are closely attached and refer to the latter

while unifying them. They have no other introspective characteristics than are indicated in their attributive relationships. Motion is not blue or low-pitched or intense. It can only be described in terms of the sensations which produce it. We cannot separate motion, or melody, or distance, or interval, from their sensational basis and recall them without it. Every time we recall a melody, we do so by recalling the tones of the melody, which then unite to form it or recreate it. Nor do melodies or motions associate of themselves and in isolation from their bases into systems. They associate only in so far as do the unities of tones or visual sensations which they constitute. It is important to remember these things in view of the study of states of mind such as feeling and thought.

These comparatively simple cases of motion and distance must serve as a guide to the study of the other more complex modes of sensory experience, which present peculiar difficulties to the student, and are only imperfectly understood at the present time. A single example must here suffice. Let us make a brief survey of the factors which bring about or modify stereoscopic vision.

By stereoscopic vision is meant the seeing of points or surfaces as at different distances from the eye, whereby many-sided objects often appear to be solid, apart from all indications of colour, texture, perspective, shadow, or overlapping of contours. It may be demonstrated in pure form by a stereoscopic slide of two points, as described below, or by the positions of two glowing cigarettes in a perfectly dark room or railway carriage.

1. As we find it in ourselves, the mode of depth is usually dependent upon the use of the two eyes. If we shut one eye and look through a mass of leaves and branches, our awareness of their relative distance from the eye is very much impaired. Everything seems then on the same plane, almost as in a photograph. Now the two eyes form, as it were, two spectators, each viewing the scene from a different standpoint and receiving, of course, a slightly different impression of it. If the reader will stick two pins into a flat surface and

hold it at arm's length, the heads will seem to the one eye to be nearer together than to the other. And if a stereoscopic picture is made by marking two points on a postcard as far apart as are the two eyes, and by adding on the same line two points, one next each of the first two points, but the one about two millimetres farther from its point than the other is, the slide will show in the stereoscope one point apparently nearer the observer than the other. The impressions from the two eyes thus produce an integral sensory result, in which degrees of depth appear.

When we view the slide in the stereoscope, the two points seem to lie in front of the middle line of the face; whereas, to the left eye alone, they seem to lie to the right of it, and, to the right eye alone, to the left of it. Moreover, everything which lies in the line of sight of either eye (*i.e.* the line joining the eye with the point fixated by it) seems to lie directly behind the point fixated. That is to say, although we really have two eyes, these two function (Cyclopean vision) as if, like the mythical Cyclops, we had only one eye, posted between them, capable of stereoscopic vision.

When the views received by the two eyes are indistinguishable the whole visual presentation seems to be at one distance from the eye, and therefore flat. Only if the lateral distances of similar points of the two views from any one point of reference differ from one another within certain limits (allowing for certain minor deviations from a general rule), are different degrees of depth presented. If these limits are overstepped no integration takes place. We see, instead, double and rival views, one from each eye.

2. It will be obvious that the difference of the views seen by the two eyes will depend on the distance which separates the eyes from one another. For any one such interocular distance, the two views must also become indistinguishable when the objects viewed are more than a certain distance from the eyes. This range for human vision is about two kilometres; but then, if all perspective, shadow, and other secondary sugges-

tions of depth are excluded, the one point must stand about one kilometre in front of the other to be really seen as nearer. If, however, we could virtually increase the distance between our eyes, we should increase our range. This we can do by an arrangement of reflecting mirrors; while, if we take photographs of the heavens on successive nights, weeks, or years, as need be, we can see in the stereoscope the heavenly bodies one in front of another, as a creature might whose eyes were many millions of miles apart.

3. If we cut the stereoscopic slide of the two pinheads so as to separate the two views from one another, and then interchange their positions in the stereoscope, we shall find that the pin that was previously nearer now seems the farther off. Thus it is evident that the conjoint work of the two eyes is no mere sum; the contribution of each is specially effective, and may therefore be supposed to be distinguished by a special psychical feature, which we may call the systemic sign. The sensations from the two ears differ in the same way. There is perhaps more introspective justification for the acceptance of a systemic sign in the case of the ear than in that of the eye. As the functional justification is for both the same, the introspective superiority of the ear may be used in support of that of the eye.

4. The general scale of depth differences depends upon the degree of convergence of the eyes. High convergence reduces all presented depths systematically to a lower scale. This can be demonstrated by pushing the two halves of the stereoscopic slide closer together (convergence) or by pulling them slowly apart (divergence). The presented objects will seem to shrink or swell in all three dimensions. The apparent extensity of visual presentations is, therefore, also dependent upon the degree of convergence of the eyes. How this effect is psychically determined it is at present impossible to say. As the scale of the retinal impression made by an object varies inversely with its distance from the eye, the combined effect of this rule and that for convergence is to produce some approximation to

equality in the apparent size of one and the same object within the range of distances over which convergence differs. We do not, as is often said, merely remember or know the real size of objects, but to a large extent we really see their "real" size. A flat photograph distorts the appearance of things because it removes the possibility of viewing the objects in it under varying convergence. The artist does not paint after the photographic manner. His drawing keeps more in touch with the apparent size of things. In this, as in all other respects, far from being nature's realistic portraitist, he must always be the soul's delineator—the impressionist.

5. The mode of depth can be produced, not only by binocular, but also by uniocular stimulation. Like distance, its integration may involve either simultaneous or successive sensations. Those birds whose eyes look out from the opposite sides of the head can see only very few objects with both eyes at once. How can they, then, make their way safely through such a maze of obstacles as a bush or tree? They must surely be able to distinguish the exact places of the branches and leaves. Experiments similar in kind to a cinematographic representation of moving objects, or, better, of objects past which the cinematographic camera has been moved, help us to realise that birds experience depth clearly when they fly. Each of their two eyes then occupies successively positions which give slightly different views, containing the same differences as, presented simultaneously, give us our experience of depth. Animals that enjoy uniocular stereoscopic vision must, of course, be aware of the direction and of the rate of their bodily progression. These are the factors which represent for them the systemic signs and the interocular distance of binocular vision, and without which the sensory basis of stereoscopic vision in them would be quite undecisive. No uniocular analogue to binocular convergence can be indicated as yet, if there is one at all.

As uniocular stereoscopic vision demands the integration of successive views, and therefore the flight or

rapid motion of the observing animal, it may be called progressive, to distinguish it from binocular stereoscopic vision, which enables animals, especially the carnivora (cats, owls, frogs, &c.) to sit still, watching their prey, and to detect its slightest movement, even if that be directly towards them in their line of sight. The latter may be called static stereoscopic vision. It is obviously of great advantage to its possessor, since it provides a relatively permanent basis for other forms of mental activity, such as perception, recognition, memory, &c. It is interesting to remember in this connection that we ourselves are predominantly visual creatures.

These are the chief factors which are responsible for the extension of the primitive extensity and order of resting uniocular vision into the third dimension in stereoscopic vision. This extension is, however, only the first stage in the construction of our complex visual space, which seems so much vaster than anything the eye can appreciate at one glance, and so permanent and illimitable. Moreover, visual distances are not only given in the special stereoscopic mode, but are also indicated to some extent by colour-tone, brightness, shadow, and outline; and most intricate distinctions are made between the motion of oneself and of objects, between apparent and real motions, or distances, or sizes, or colours. These problems involve to some extent certain generic modes of experience to be mentioned later. For the rest their study, as that of all other forms of complex sensory experience, must proceed on the lines of which the main directions have been indicated in this chapter.

CHAPTER III

THE CORRELATION OF THE SENSES

THE great problem of the physiologist is to understand how the vast colony of cells that form the human body live and work together so as to form a single individual. A similar problem arises for the psychologist. We have reviewed the chief classes of sensations and their first modes of complication. We have now to understand how all these elements and primitive modes work together to form the harmonious individual mind, in which each experience is a part of the whole, and, in principle at least, takes account of every other part. Let us therefore next consider how the various sensory modes are correlated with one another.

Their correlation is an undoubted fact. For our estimation of the relative positions of all objects which lie within a certain distance from the eyes is rarely upset by a closer view. We can reach for things we see with speed and accuracy. Hand and eye work together, and what the hand judges the eye will confirm. Not quite so sure is the co-operation of eye and ear. But we can usually look for a source of sound in a very likely quarter. Exact measurement and decision certainly put an excessive demand upon the accuracy of our senses. But for all ordinary purposes measurement may be made by the unaided eye, especially when only comparative and not absolute lengths have to be estimated. And even the use of a foot-rule presupposes a high degree of accuracy in our visual judgment of equality. We can therefore compare the varieties of one and the same mode of one sense, and also those of the modes of different senses with one another, and, if need be, express one in terms of the other.

These things can be exemplified by the simplest experiments. Let an experimenter touch any point on the arm of another person, a blindfold observer. The latter may express his localisation of the point by touching it, thus correlating touch with the sensitivity of joint and muscle; or, using his eyes, he may indicate the position of the spot upon a plaster model, or upon a photograph of his arm, or upon the arm of another person, thus correlating touch and vision; or a spot on the skin may be pointed at while the observer is looking, and the attempt then be made by him to touch the same spot blindfold, thus correlating vision with articular sensation and with touch. Similarly, a sound may be located by pointing to its supposed place of origin or by locating it upon a chart.

This manner of co-operation between the senses is so obvious that it has always formed an important and interesting problem. It has, indeed, often been considered to be presupposed by the apparent development of certain modes in senses which did not seem to be able to provide them of themselves. Thus Berkeley held that vision did not of itself provide us with our appreciation of distance, and tried to prove that the visual appreciation of distance we acquire is derived from the constant association of vision with our sense of the number of paces or miles we must walk to reach the distant object and to touch it. Many still follow the lines laid down by Berkeley in holding that an attribute or mode may seem to adhere to a sense in which it is not native by virtue of the associative correlation of this sense with a sense in which the attribute or mode is native. But this kind of genetic theory seems untenable (cp. p. 26).

A more recent attempt to solve the problem is the theory that the common features of different experiences are due to the identity of the muscular response we make to them, quite apart from any sensations which may be aroused thereby. But if the previous theory postulated too much, this one may be said to postulate everything; for it offers an explanation

which cannot possibly be verified to the extent of its application, and which contains in itself no whit of real advantage. What more do we know about experience when we know that the response to one and the same experience remains identical, that experience and response vary together, and that the same or similar aspects of experiences of different senses evoke the same or similar responses ? This would, after a fashion, explain muscular or effective correlation, but it would not explain psychical correlation. Besides, there is no real evidence for anything more than we should expect —a similarity of response to the same experience, and a rather degraded reflection in movement of our fine sensory discriminations. The number of different tones that can be sung by the finest voice is only the merest fraction of the number of different tones a fine ear can discriminate.

It must, therefore, be clear that we cannot now ask which sense is the original source of distance or position, or which sense is the standard for the others, or which is the original sense. To these absolute questions we must answer that each must contain in itself a basis for all the modes it develops by itself or gains by integration with the elements of other senses. But certain relative questions may be asked. We can, *e.g.*, ascertain which sense, if any, we take as a standard, whether as regards its elements or its modes. We must expect to find all sorts of individual differences in the choice of a standard sense. Of course, only a sense that possesses a given mode can become a standard for that mode. In one animal species one sense may be more highly developed than it is in another, so that standards may be sought in different directions. We should certainly not be helped by referring sight, sound, and touch, to smell, as most animals do. In one and the same species we shall doubtless find parallel lines of standardisation. We find our standard of texture of surface in touch, but our standard of distance is surely that of visual breadth, or ultimately that of visual coincidence of distances. This we express when

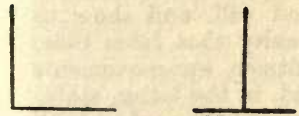
we say a thing is so and so may spans, feet, inches, broad or high. While our standard of direction is visual, it is undoubtedly auditory for many kinds of animals, especially for those that are usually short-sighted, *e.g.* herbivorous creatures like the horse and rabbit. Amongst ourselves, finally, we find many differences, which emerge, not so much in the rudimentary forms of sensory correlation and perception, as in the constructions of memory and reasoning. One person's standard of reference is visual, another's auditory, another's muscular. These differences are known as types of imagery. We shall return to them again.

While studying the correlation of the sensory modes, we must not fail to refer to a group of exceptional cases upon which an immense amount of most patient and laborious research is being directed—the illusions. These are so called because the usual systems of correlation of sensory modes, to which we are adapted, seems in them to be at fault. Lines seem to be longer than measurement shows them to be; figures appear solid that are not so. A number of examples are shown in Figs. 2–8. What explanations can be offered for these things?

Consider Figs. 2 and 3, in which the upright lines seem longer than the horizontal ones. It may be that this is a result of the physiological nature of the eye, whereby lines of equal length produce a longer vertical than horizontal retinal stimulation. Or it may be that a line appears longer when upright, because the total extent of the field of vision is not so great in that as in the horizontal direction. Contrast would thus play a part in our estimation of length. It is very difficult to prove either of these views, especially in the case of short lines; for them the retina is practically flat, and all proportional relationship to the extent of the total field of vision surely vanishes.

On the other hand, it might be suggested that it is harder to move the eye up and down than sideways,

Illusions



Figs. 2 and 3.—Compare the upright line with the horizontal in each case.

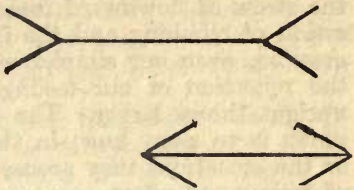


Fig. 4.—Compare the length of the two horizontal lines.

Fig. 5.—Compare the space covered by the row of dots with the space between them and the single dot.

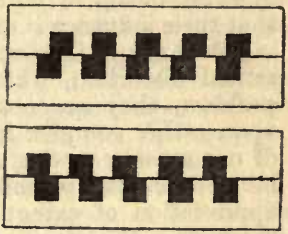


Fig. 6.—Compare the directions of the two horizontal lines.

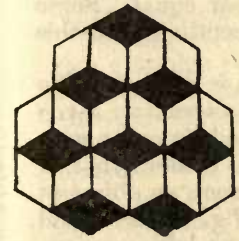


Fig. 7.—Look at the figure steadily until it changes its appearance.

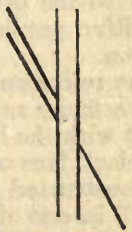


Fig. 8.—Which of the two lines is the continuation of the other?

because we are naturally compelled to acquire greater practice in the latter direction. Or, to appeal to another quarter, we might suppose that, as we have always felt the stress of downward forces upon ourselves, the exertion of climbing and the freedom of horizontal progression, even our simpler mental acts have taken on the reflection of our feelings and will, and show us upright things larger. The difficulty that faces these views is to show how, in the former, eye-movements or the sensations they arouse, and, in the latter, states of feeling and effort, come so closely into contact with the elements of sensory experience as to disturb the integration of their modes. It is one thing to bring forward evidence for the correlation of an illusion with eye-movements or efforts and another thing to show that their influence is direct and intelligible.

The study of illusions shows that, apart from purely retinal distortion, which, of course, offers no special problem, they are not based upon the simplest but upon rather complex interconnections and correlations of our sensory modes, and more especially upon those involved in our appreciation of spatial extent as against appreciation of extent of line. There is evidence to show that the stronger the habit is to compare the lengths of actual lines, the less the illusions are noticed; while, if the attention is turned upon spatial extents, apart from all actual lines, the illusion increases. Thus, when the horizontal lines of Fig. 4 are coloured differently to the others they readily appear equal. Some primitive peoples also show little susceptibility to this illusion.

The reference to our sensory modes is given also by such a figure as No. 7. This presents alternately seven cubes with the black face undermost and six cubes with the black face uppermost. It must be evident that, if we constructed a stereoscopic slide of such an object as Fig. 7 in one of its aspects suggests, Fig. 7 itself would be available either as a right-eye or as a left-eye view. If it were used first as a right-eye view, reversal of depths could be got in the stereoscope similar to that

given by the illusion, but, of course, much more striking and permanent, if it and its fellow left-eye view were interchanged. This illusion may, therefore, be described by saying that a given view of a solid object seems to supplement itself alternately by possible right-eye and left-eye views, and to change its apparent solidity correspondingly.

It is interesting to consider this illusion as an elementary form of memory based upon the rules of sensory integration. The outline of a cube drawn on paper does not appear the same to the experienced eye as it would to the eye of a grown person whose sight had just been restored. To the latter it would suggest merely a group of lines upon a surface ; upon the former it acts as a part of the characteristic complexes it has usually appeared in. Thus the stimulus produces at one time one effect, at another a greater effect. Which of the two possible greater effects it will produce at any moment depends upon various circumstances, such as the point of the figure fixated by the eye, the length of time one illusive depth-aspect has already lasted, the effort of attention or will. Although one stimulus thus produces a variable effect, the presence of a variable part, added by memory, has not been adequately proved. It is obviously difficult to do so ; for the integration of the hypothetically direct and reproduced parts must be as close as in the case of stereoscopic vision, the analysis of which is by no means easy. This field of problems is still in course of being studied.

But there are many cases in which a part of a complex stimulus can be proved to arouse experiences it would not of itself have aroused but for the previous action of the other parts of the stimulus. Sometimes the revived parts are fused with the direct parts just as closely as in the case of the illusory cubes (Fig. 7). Sometimes the direct and the indirect factors are so separate that they can be easily distinguished. These indirect parts are known as mental images because of their likeness to the sensation directly aroused by the corresponding part of the stimulus.

CHAPTER IV

THE PERCEPTUAL MODES OF EXPERIENCE

We have still to consider the question how the correlation of parallel modes of different senses is brought about. It has often been considered sufficient if the answer refers extensively to practice or to past experience.

Let us consider the case of a puppy hurriedly struggling to adjust himself to the busy world. He undoubtedly appreciates both visual and auditory positions at an early age. He can avoid a visual obstacle and he can jump away from a startling sound. If he is called from an unusual direction, for example from above, his head turns promptly towards the source of the sound but not upwards. He seeks it on his own level. Probably his discrimination of the vertical positions of sound is as bad, compared with that of their lateral positions, as is our own.

A second call will not make him turn away, but rather run towards the caller. Now suppose the latter, annoyed by his persistent barking, throws small lumps of earth from the window-box at him. The puppy may take the assault playfully at first, but persistent attack will make him look up and flee. When this has happened once or twice, a call from above will make him look upwards at once or flee without delay.

Here we have an extension of the first simple correlation of unambiguous modes. The precise localisation given by sight in conjunction with other senses has been lent to hearing. But we have also more than that. A call from a certain direction has become a signal for flight, for silence and attentive watching,

lest some evil befall. So a whip on the floor may be a rare plaything, while a whip in the hand is an enemy to be avoided. A certain dish is the thirst-quencher, another the food-store. How these connections present themselves to the animal's mind it is, of course, hard to say precisely. We find, however, in our minds a number of similar cases, in some ways more elementary than these. We see birds so frequently in flight that a picture of one in the air immediately calls up in us the adjuncts of our usual visual perception. We then "see a bird in flight." How different this is from what we "see" in a picture of a human being prone in the air! So, again, a piece of rubber tubing "looks" soft, buckram looks stiff and scratchy, the grass often looks wet, the air looks hot, and a book looks heavy.

Pavlov's ingenious physiological experiments upon animals help us to study the development of these connections, which take origin most readily in certain inborn impulses, such as that towards feeding. This impulse consists at first of a few main connections between impressions and movements, of an almost automatic nature. When a suitable object is placed in the mouth it excites there sensations of touch, taste, and smell, which forthwith bring into operation the action of swallowing. At the same time saliva begins to flow. When a dog has thus "learnt" the smell of suitable food, the smell alone will excite a certain flow of saliva. In fact, almost any impression accompanying the full action of feeding will, after a few repetitions, suffice by itself to stimulate the flow of saliva. Thus one of these inborn, main, pathways, by which a stimulation passes from a sense-organ to a gland or muscle, seems to attract to itself any other stimulation which comes to the brain at the same time and to use its energy for the action in hand. The exact track by which the accompanying stimulation joins the main pathway can also be discovered by methods which are easy in principle, though very difficult in practice.

Such experiments prove that dogs have an almost perfect or "absolute" ear for pitch (quarter-tone differ-

ences) and intensity of tone, but very poor vision, being blind to all colour. They also show us what impressions can be connected with or grafted on to the main, inborn, pathway, how rapidly and to what extent they become effective and how long they will outlast their effectiveness. For it is evident that their biological "purpose" is to prepare the animal for the reception of the food which usually accompanies them. If the food no longer appears in their company, it is clearly desirable that they should no longer act as warnings; and, in fact, they do then gradually die out.

Although the results of these experiments are chiefly physiological, it may be inferred from them that the experiences which are aroused by the primitive impulse of feeding also combine to form a unitary group, and that experiences which accompany this group gradually incorporate themselves in it and become joint heirs of its activity and pleasures. So the dog will "attend" to the sight of his feeding dish or to the hand that bids him beg. For a similar reason he ceases to attend to the actions which brought him punishment. The degree to which the engrafted experiences may diverge from the original stock, whether in time or otherwise, differs from one class of animals to another and from age to age. It constitutes largely what we call intelligence. A young animal must be praised or punished immediately after the action concerned. A dog "knows" from whom to expect food, but when he growls if the giver stands too near to his mouth he shows that he has not learnt what giving means. The little child is in other ways for some time just as ignorant. When the dog greets his returning master, known by footfall, sight, and smell, perhaps then, however, there is more in his experience than a narrow grouping of sensory modes, their muscular expression, and pleasurable feeling. Is not his lord the object of his delight, because he has returned?

In this last case we have the two modes of perception and recognition. However difficult it may yet be to formulate the terms of their occurrence in the animal,

we undoubtedly do observe and recognise particular things. By " that " (orange) we mean, not the sensations of orange colour, of smell, of weight, of coolness, of acid-sweet taste, but the unity of all these, which we fix by the name orange.

It is just because primitive perception is an integration of many sensations and sensory modes that in our naïve, unreflecting attitudes we seem to be directly face to face with objects. The unity of all the appearances of the object present to us we take to be the permanent thing, independent of our individual minds. Our gaze seems to go up to the object, round it, and on to objects beyond it. But if we extended this unreflecting attitude to all our perceptual activity, we should have to assert that the real, permanent things come inside the mind when we perceive them; for distance, depth, and space generally being modes of sensory experience—whatever is in this space is in the mind. We do not, of course, make this sweeping generalisation. Perception is often very complex and interwoven with memory and judgment. Atoms, and chairs, and horses, and friends are not inside our minds. We come to learn that unless things affect our sense-organs and evoke sensations we should never know them, unless it were indirectly through experiences evoked by other things. The object for primitive perception is, therefore, best described as a " that," a joint unity, which the integration of certain sensations and of the modes derived from them constitutes for us. Each perceptual " that " is, doubtless, distinguished by some sensory mark, attributive or modal, simple or complex; to save explicit analysis in ordinary experience, and, as also in science, for brevity, we distinguish them by names whereby they can be arranged according to any plan that seems good. The more natural and " objective " the plan, however, the more stable and the more apt it will be to produce certain further, desirable, psychical effects, especially in the sphere of judgment.

Probably the correlation of sensory modes is aided

in its less unambiguous regions as much by perceptual unity, as the latter is at first established by the former. Without the correlation of the sensory modes of order and its derivatives—motion, distance, and depth—of duration and place in time, and of intensity and similar lines of change, we should hardly achieve even the perception of a momentary "that," a particular object. Without perception we should hardly manage to extend the range of our sensory correlation as far as we do.

The study of the origin and of the development of perception is exceedingly complicated, and very little is known exactly about it. Experimental analysis has first to work towards the elements which compose it before their arrangement can be understood. It is to the attributes of the integrating elements to which we must look for explanations of the arrangements of complex modes of experience. We must look upon experience as homogeneous, not as divided into two parts—the senses and the higher spheres. A psychology of perception will therefore have to wait upon a psychology of the senses and of their elementary modes. To refer to "past experience" is quite insufficient, because any integration of experiences is brought about, not after and because they have passed away, but while they are present. The animal profits, not because it has had experiences, but while it has them. The problem of past experience is not to explain full integration, but to explain why, when a part of an already integrated complex is given, it is able to revive its integrative complement.

The first and simplest step forwards in complication from primitive perception seems to be the state of recognition, which, of course, embodies a relation between separate and successive occurrences of the same perception. A full discussion of it would necessarily involve the main problems of all the more complex perceptual states.

Several theories of recognition have been propounded

by psychologists. The simplest claims that an experience is recognised when it has revived a group of experiences with which it first or previously occurred. Their recurrence is what constitutes recognition. But, without further explanation, such a theory must break down; for both general and experimental observation show that the act of recognition may occur before revival by association appears. The two processes have rather to be distinguished than identified. Revival by association usually brings an addition to the act of recognition, namely, the reference of the recognised experience to its first or previous occurrence. For these reasons it has been supposed that recognition consisted in the incipient psychical or physical revival of associated experiences, a sort of unconscious excitation. But not only does this explanation lie outside the limits of experience, thus failing to satisfy the demand for a purely psychological theory of recognition; it has also to explain why actual revival can sometimes take place without producing recognition, as experiment has proved. It must be evident that mere revival is not enough. What is revived must not be merely the previous accompanying circumstances, but these as a definite group which, when it recurs, will stand before the mind as a unit, similar to the perceptual unity of the recognised experience. Recognition, therefore, presupposes the perceptual mode, both in the object of recognition and in any revival which may serve to give it a specific reference. It may be said to be the mode of experience which results when a perceptual mode, in virtue of the place or "order" in experience which its integration constitutes, revives or begins to revive the larger inclusive percept of its former occurrence.

It is impossible to give a satisfactory theory of its relation to revival yet We must wait till further research provides us with increased knowledge. But this much, at least, seems to be implied in recognition: our past experiences do not disintegrate, like the iceberg when it mingles with the warmer seas. They maintain

their particular structure, and, within the limits of recall, are available for the completion and elucidation of our current life. If so much is certain, it seems necessary to claim that, both as elements and as modes, they in some way endure and are permanent. It would be rash to assume the permanence of modes without permanent elements as well. But it is possible that, unless preserved as modes, they are not separately preserved as elements. Self-identical elements may, of course, recur without our being aware of any recurrence; for it is only in virtue of integration already undergone that an objectively recurring experience can revive its previous perceptual setting in the mind and so be recognised. That we forget is no objection to this view; for it would only mean that we are sometimes unable to revive past experiences, not that these have utterly vanished from creation. Besides, the scope and the objects of forgetfulness are to a greater or less degree within our control; and it may be that in wilfully remembering we are helping to make more permanent what will serve as the basis for the further development of experience, if not of life and of the world itself.

CHAPTER V

MEMORY

THE existence of mental images is one of the familiar facts of psychology. Most of us can see with the mind's eye what is not actually before us, and can, sometimes at least, hear the words we frame our thoughts in without actually uttering them. But these are not the only kinds of mental images. There can be no doubt that all kinds of sensations can be revived upon occasion, although we may not often notice the occurrence of certain kinds. Mental images are so called because they closely resemble the various classes of sensations. So close is the resemblance that it is difficult to say wherein they differ. A mere difference of intensity or liveliness has been asserted by some, while others speak of images as revivals by memory, or as sensations aroused centrally, not by stimulation passing from sense-organ to brain-centre, but by stimulation which reaches the latter indirectly from other parts of the brain.

But an image need not differ from a sensation in respect of any attribute. Recall a rose; the imaged quality of redness may be identical with the previously presented quality; it may be equally extended; it may be localised in its previous surroundings and in the same spatial relations to oneself; and it may be equally intense. Certainly we do not normally think it equally intense; but neither do we remark any difference of intensity. When I speak "to myself" I do not whisper; I can hear myself speaking in my usual voice. I can also imagine myself whispering. Indeed, if only relative differences in intensity or in any

other respect were retained, a confusion would necessarily arise between sensations of low intensity and images of high intensity. But it is only under unusual circumstances that we have to ask a friend if he also hears certain faint sounds we may describe. Obviously the basis of distinction cannot be a general reduction in the scale of intensities, unless sensations only occur in a part of the scale widely separated from the part in which images occur. There is no evidence for this. If both sensations and images have intensity, the difference between the two must be something which is not itself intensity. The same reasoning applies to all other attributes and modes of sensory experience.

It is evident that in our primitive experience, when we make no test to see whether our experience is immediately dependent upon the stimulation of our sense-organs, we cannot distinguish between different forms of experience, so far as these do actually share all the characteristics of what is really sensational and so are dependent upon such stimulation of sense-organs. The distinction of sensation and imagery must, therefore, depend upon our ability to say whether an experience has come about through impression from a real object or not. This is often expressed by saying that in dreams we take our imaginations for reality, because we have no reality by us to compare with them. So also we find that, in abnormal states of hallucination and even in the ordinary operations of memory of many persons, what is really imagery appears to be qualified by all the spatial features of sensational experience, including that of relation to the self or person. In the latter cases all the sensations of the moment may be ignored in favour of the imagery.

Even in ordinary life a considerable amount of restriction is placed upon our ability to test the origin of our sensory experience. In turning over the pages of a book one is often struck by a thought, a curious word or phrase, and imagines it has occurred spontaneously to the mind, whereas a little search may show that the mental picture came from the book itself. One often

"remembers" a tune only to find that someone is humming it gently or that it is being played in the distance. Here absorption in other things is responsible for the momentary want of distinction. But there are many cases in which the psychophysical distinction is quite difficult to make. It is hardest when sensations revive imagery of their own sense and the two fuse into one whole. It is easiest when image and sensation belong to different senses, or when the imagery brings features incompatible with the continuous flow of that experience which we have learned to connect with the material world. It is, therefore, evident on the whole that many complex mental processes and a fairly highly-developed perceptual and conceptual intelligence are involved in any distinction of sensation and imagery.

Simple experiments will convince anyone that much of what we ordinarily suppose we see and hear is recalled. Our first inspection of a new invention, a dress, a picture, a stranger, is long and careful. Afterwards we recognise many details with "half an eye." The understanding of a foreign tongue puts at first a severe strain upon the attention. Later we only listen to half of what is said, and have time to think between whiles of what can be said in reply. If we expose a simple picture to inspection for a fraction of a second at a time, we notice readily that with each exposure more and more of it becomes visible at one time. But it is not all sensed; much is really imaged. This can be proved by making substitutions in the figure exposed. They will often pass unnoticed, while the presence of the familiar displaced component is vigorously asserted. Only a few disconnected consonants can be read at a glance—some five or six—for all of them have to be really sensed; of letters forming sensible words and phrases twenty or more can be "read" at once, because only the characteristic parts need be sensed, the rest being revived by them as imagery.

In these cases the imagery is so closely fused with sensation that their distinction is possible only by in-

direct means. The fusion is naturally closest when both sensed and imaged components belong to one sense, as in looking at a picture or listening to speech. The fusion is also close in many cases where a sensation of one sense seems to evoke imagery from other senses through the medium of perception. So a large stone looks heavy, a cheek looks soft, a toad looks slimy. In these cases, however, it is uncertain how far there is any actual fusion of visual sensations with imagery of other senses. There must be purely visual correlatives of heaviness, softness, and sliminess, or else the perceptual correlation of these could not come about. Thus, heavy things are usually large to the eye, soft things have flowing, drooping lines or move easily, and slimy things glisten in full colours. That the presence of the visual correlatives makes us imagine and expect the correlative in the other senses can be brought out very well by the help of certain playful deceptions, *e.g.* lead shaped to look like a cigar, imitation flowers. Here is the origin of one of the great objections to imitative representations in art of any kind, *e.g.* the painting of things too realistically, as in the fable of the birds and the painted fruit, the insertion of real hoops of metal in pictures as haloes, the manipulation of metal after the manner of wood, and the use of false doors, handles, and windows to preserve an easy symmetry. Not only is imagery forced into the forefront of attention that does not find a place in the sensory material (visual) with which the artistic work in these cases is constructed, but the natural expectations of the spectator are offended.

The presence of imagery is easily noticed when the perception of an object by vision revives its auditory characteristics, or vice versa. The cinematographic representation of brisk action, falling, or collision, seems for this reason all so noiseless; and when we see words spoken in passion or grief, we feel dissatisfied till words recur to mind which fit the action. So also, when we hear the familiar sounds and voices of a house, we readily picture the actions and persons which cause

them. When we pass to the thought of an absent object we may also easily become aware of distinct and separate imagery. So a half-familiar face will arouse the visual image of the setting in which it was last seen; a smell will remind us of a railway station or train in visual form; the name of a song will recall the sounds of its melody.

The most obvious and noticeable of all images are those which have, as sensations, been the object of special delight, enjoyment, amusement, or horror. As we say, we can see it or hear it still. Here the revival is the fullest and is also the basis of much mental activity. The least noticeable are those which, as sensations, have been least independent or are most completely the instruments of integrative processes, *e.g.* articular, muscular, visceral, and many varieties of cutaneous sensations. Articular sensation, for example, integrates with tactual sensation, but the resulting refinement of localisation is referred by us almost solely to the tactual percept, or through it to the visual factors.

The kind of imagery we have at any moment depends very much upon the manner in which the remembered object was presented first, most recently, oftenest, or most intensely. It tends also to satisfy the needs of the mind's activity at the time, to enrich the sensory presentations of the moment, or, in thinking of objects other than those presented, to take the form in which these will least conflict with the impressions of the moment. It is also natural for a learner to select for memorising that form of imagery which will embody and justify the greatest number of facts and thoughts he has to remember about the objects in question. No one who has any visual imagery at his disposal would ever dream of memorising a map by auditory images. These and a number of other minor influences tend to make the imagery of all men alike.

But the possibility of variation is often still open to the learner. For most things can be remembered in several forms of imagery. Words can take the form of

their visual symbols, or of the sounds of speech, or of the muscular feelings of speaking or writing. Tones can be remembered as sounds, or by way of the motor sensations evoked by singing or playing them. Movements can be represented visually as well as by motor imagery. The following is a summary statement of the imagery used by seven persons in certain experiments made for the purpose of studying imagery.

No.	Letters.	Tones.	Movements.	Grades.
1 & 2.	v.	a	v.	v; a.
3.	a.	a.	v. m.	a ; v, m.
4.	v. a. m.	a. m.	v.	v, a; m.
5.	a. m.	a.	v. m.	a ; m ; v.
6.	a. v.	a. m.	v.	a, v; m.
7.	v. m.	m.	v.	v ; m.

v = visual, a = auditory, m = motor.

Here we see that no tones are remembered visually and no movements auditorily. Sounds seem best represented as sounds and movements as visual processes. In remembering letters the vehicle seems to be a matter of indifference. Under the heading "Grades" the letters have been arranged so as to show what might be inferred from this table as to the relative prominence of each kind of imagery in each person. A comma separates probably equal strengths, a semicolon separates probably different strengths. Thus we find four persons all possessing the three kinds of imagery most used in cognitive memory work, but in different relative strengths: (3) a; v, m. (6) a, v; m. (5) a; m; v. (4) v, a; m.

This is one of those individual differences which must always form a most important object of study for experimental psychology. We are still far from any

complete understanding of its nature. It might be suggested that it originates in the different sensitivity of certain sense-organs and the connected parts of the nervous system in certain directions; but such a view is hardly sufficient. For there can be a very good memory for impressions of weak intensity. As differences of intensity do still affect our memories, no doubt differences in sense-organs and nervous system were remotely responsible for differences of sensitivity if there is any definite degree of correlation between nervous and mental impressiveness. It might also be suggested that we remember better those impressions on which much further mental activity is based; but however appropriate such a suggestion may be, it only provokes the question why in some persons impressions of certain kinds provoke further mental activity than do other kinds. We could hardly yet maintain that persons differ in their mental imagery where a choice is possible and indifferent, only because they do more mental work with certain kinds of imagery where these alone are possible, or where these form a very much better basis for mental activity than any others that are possible. Where knowledge fails, a word may console. Let us therefore say that one person is more "receptive" to one kind of impression than is another, so that, where a choice is possible, he retains the one rather than the other, and where no choice is possible he remembers badly. We need hardly suppose that any person who has not lost sight or hearing at an early age is absolutely unreceptive to any one kind of imagery. Though the differences may be great, they are probably only differences of degree. The more prominent of these differences are often known as visual, auditory, motor, visual-auditory, auditory-motor, mixed, &c., types of imagery.

It is not easy to tell by external signs precisely whether a given person belongs to one or other of these classes. But a broad, serviceable distinction can be made between the strongly visual and the non-visual, auditory or motor, types.

The visualiser is apt to be disturbed by the sight of things around him, and therefore when recalling, thinking, or day-dreaming, shuts or shields the eyes or gazes before him at some indefinite point which does not usually lie on any of the objects around him. The auditory type is less disturbed by the sight of things since, in listening or thinking in words, he tends to withdraw his attention from the visual field altogether. In eager listening, however, this abstraction from vision is usually made more complete, and the listener sits motionless, lest the noise of his breathing and of the motion of his joints should disturb him.

Moreover, in visual imagery the parts of any one unitary group of images are often all present at once, whereas in auditory and motor imagery the parts are usually revived one after another. Few people can distinguish from one another several tones heard or remembered together; but surely no one is unable to distinguish the different outlines and larger distinctions of colour in a visual field. But a large visual picture takes a little time to revive completely, so that the visualiser often makes a slight pause before beginning to speak from memory, and can usually take material from his visual image in any order. Auditory images, on the contrary, are learnt and recalled in a certain order, which it is not easy to change, and, as only the beginning of the thread has to be found, recall may start sooner. It is also usually faster, because each repetition in learning by sounds reduces the interval between them, whereas it only stamps the visual image more firmly and clearly on the mind, the process and rate of verbal recall being left to the actual moment of recall. The visualiser also tends to know in what relation what he is recalling at any moment stands to the whole work, because he can have the whole image before him. The sound-images, being successive, do not lend themselves so naturally and mechanically to this certainty; but they may do so if there is some form of unifying structure present, as, *e.g.* in a musical composition or in poetry. The auditory type, if not sure of the whole of

a word, will often remember the vowels better than the consonants; visual memory shows no such preference. Finally, the mistakes made by auditory minds sound alike, *e.g.* "the whole thing" and "the hold thing," while those made by visual minds look alike, *e.g.* "causal" and casual," "aerated" and "areated."

The imagery that is revived by the idea of any object is not usually the equivalent of all the sensations that went to form the percept upon its first occurrence. It is usually only one set of these, perhaps the most characteristic, the most intense, the oftenest repeated, or the most interesting, and it now supplements the idea of the object as already revived by any means. It does so in virtue of the fact that it has formed a constituent part of the integrative perceptual mode. For these reasons imagery is often said to be representative in function.

But even sensation is often called representative, especially when it enters into a perception and so arouses the idea of its own source or cause. In distinction to this view, sensation is here treated as presentative. The limitation of the scope of these terms, "presentation" and "representation," is the subject of much controversy at present. The psychological student may be guided by the following considerations. Experience can be neither wholly presentative nor wholly representative. If it were the former, memory and knowledge of objects independent of the individual mind would be impossible. If it were the latter, self-evidence would be impossible and experience would at no point be completely convincing or justifiable, because it would still point outwards from itself to its final justification. But the function of representation cannot begin abruptly; it must be founded in the nature of the presentative part. It will therefore be necessary to distinguish degrees of representative function. When the mass or scale-pitch of a very low or high sound represents for us a tone which we cannot clearly revive, we have a lesser degree of representation than when a

name represents a face, a character, or the structure of a molecule.

On the other hand, the mere reference or attachment of one form of experience to another does not necessarily imply representation. The two notions must be carefully distinguished. In order to explain the reference of a state beyond itself, it is not necessary to suppose that mental states are not fully conditioned or caused when they first come into being in the individual mind or that part of their conditions lie outside the conscious mind. Such a view would be incompatible with the rationality we postulate for all forms of being. The reference and attachment of motion and distance to their sensational bases can be explained satisfactorily, and we may expect as much of other forms of reference. Representation includes reference, but implies more than mere reference.

It is the essence of representation that a part of an integrative complex is able, after the integration has once taken place, to do alone what could at first only be done in conjunction with many other similar parts. Perhaps the simplest example is found in the illusions of reversible perspective (*v.* Fig. 7, p. 39). There a set of lines, which at first formed the view of a solid thing as seen by one eye only, now does alone much that could previously have been done only in conjunction with the view obtained by the other eye. The mode of depth given in the illusion is not usually complete, though it may be made so experimentally when the observer has no idea how many views are given or whether the object is drawn or really presented in solid form. It is usually illusory; it seems solid, though hardly of any definite thickness in the line of sight, as does often an object of which we can only catch a glimpse; and its solidity fluctuates and alternates abruptly from positive to negative according to the trend of various circumstances. It may represent for us any form of solidity with which we are familiar and which is consistent with its own nature as part stimulus to a depth-mode. It may even appear flat, but the other possibilities are

so numerous, so familiar, and so much more usual, that it very seldom does so. In waking life we both know and see that it is flat, because both eyes are stimulated in the same way when we look at it; but because of its integrative connections it also at the same time revives the idea of a solid object and appears solid.

We may, therefore, suppose that in memory a part of an integrative complex is able to revive the mode which results from the integration and thereby also other parts of the integrative complex. We may also suppose that the integrative mode retains its reference and attachment both to parts that are revived and to parts that are not revived. How exactly this process of imperfect revival is to be made theoretically compatible with the process of complete integration, whose rationality we must postulate, we cannot attempt to say. But where there is some hope of being able to explain certain complex forms of experience in terms of the simplest elements to the complete satisfaction of rationalistic demands, it would not be helpful, in face of the problem of imperfect revival of integrative basis, to revert to the view that all experience is representative, bringing references it never has justified and never can justify completely.

This process of imperfect revival is involved in the theoretical treatment of memory by means of the notion of association. A chick has at first the tendency to peck at anything small—a crumb, a spot of paint on linoleum, its own toes. What it finds distasteful it quickly rejects and ceases to pick up or even run towards. It may run part of the way towards an object it has already found to be distasteful, but it will often stop short of the object, move its head as if it were tossing something nasty from its beak, and even scratch the taste off. Here, at first, the visual stimulus produces one effect, the nasty taste stimulus the opposite. Later, the visual stimulus produces both effects, first one and then the other; finally, it produces only one weakly or none at all. Physiologically we may here

suppose that the visual stimulus provokes approach by one nervous track and by another the act of rejection and inhibition of approach. But the latter can only come about if we suppose that the visual stimulation somewhere strikes into the track used by the nasty taste stimulation. Any psychological interpretation must involve a similar coalescence of vision and taste. This may be expressed without any reference to the difficult problems of perception by saying that the vision and taste here associate with one another. Of course we must not see any virtue in the avoidance of the problems of perception. We shirk them for the moment only that we may progress with the study of more easily accessible aspects of the question.

An association is said to arise between two or more experiences when these are together in the mind simultaneously or soon (within a few seconds of time) after one another. A unitary mode of experience in which these experiences are integrated is always presupposed, although it is usually ignored. The time-limits for the formation of associations remind us of the time-limits characteristic of all those integrative processes that may be based, like distance, on simultaneous or successive experiences. Once an association is formed between two experiences, one of them is able to revive the other in virtue of the association between them. The oftener the experiences are conjoined the quicker will the one be able to recall the other, the longer will it be able to do so without further repetition of conjunction, and the less often will it recall some other experience "by mistake." For this reason an association is said to vary in strength, and the signs of strength are speed, endurance, and, in certain ways, accuracy of recall.

There can be no doubt that association is a most important factor in recall and that it is not a necessary factor in any process of complete integration, and may, therefore, well be treated apart from the problems of integration. Within the time-limits of integrative processes that can be based upon successive experiences the integration takes place immedi-

ately; it needs no repetition. So the figures 3, 8, 9, 2, 5, 1, 4, or the letters b, m, x, v, l, can be remembered by immediate memory so long as we keep the attention uninterruptedly upon the group. This unitary attention is not disturbed by attending to or uttering any member of the group. But when the parts exceed a certain number, which varies for different persons and ages, the learner can no longer hold all the parts together and consider or utter any one without detriment to the others, unless he repeat the series a number of times. The mental energy available at one effort seems to be inadequate to this task. We might fancy that a stream of energy had to be supplied by the will in the form of repetitions, so that it might thereby be turned into a permanent form and made independent of the will in the form of associations. We come here into the sphere of mental work, effort, and will directed upon the work of learning. Hence emerge a large number of questions of importance to the practical work of mind—questions of economy. How can a given number of repetitions be so arranged as to make the strongest associations? How should each repetition be made so as to give the best effect? What is the minimum strength of association necessary for recall? Does association lose strength in time, and, if so, how?

In the experimental investigation of these questions it is usual to make an observer learn series of nonsense syllables—wouk, veir, san, jaup, daeg, lem. These are chosen because in them we have eliminated a very large part of the memory work of the observer's previous mental activity. Any other material may well be used which revives as few associations already formed as possible. To achieve this we must necessarily reduce the units to be learned nearly to the perceptual level of group-objects present to eye or ear. But obviously we cannot go farther than this, because memory always implies perception at least. These syllables are made as uniformly as possible; every precaution is taken to avoid any suggestions of meaning, and the order and rate at which they appear to the learner are kept under

strict control. Careful arrangement of the repetitions of the series of syllables (which may contain 8, 10, 12, 14, 16 or more members) is necessary to ensure a proper test.

When the numbers of repetitions necessary to learn a series of syllables for the first time are counted, we speak of the "learning method"; when these are compared with the smaller numbers required for re-learning, we speak of the "saving method," because the difference may be considered as the amount of learning-labour saved. When the memory of the series is tested by asking the learner to name the syllable which occurs after any syllable shown or named, we speak of the "scoring" method, because the learner's memory is often insufficient and the numbers of correct answers scored, therefore, constitute valuable statistics for comparison. These numbers, as well as their average recall-time, can be correlated with the number of repetitions allowed for memorising. Partial correlations can also be made, *e.g.* between repetitions and scores for short recall-times (less than two seconds) or for longer recall-times.

The amount of repetition necessary to learn a series of syllables that cannot be taken up into the mind as a whole at once is exemplified thus:

No. of syllables in each series .	7	12	16	24	36
No. of repetitions needed to learn .	1	17	30	44	55

Of the members of a series the first is remembered most easily, the second and last next most easily. The hardest to fix are those in the middle. The idea of a group as a whole very readily leads to the revival of the first member, and the revival of the last member leads very readily to the idea of the group or to the first member. The first is the characteristic beginning of the whole, the last is that part of the whole which gets most time to produce its impression upon the mind. The process of associating works from these two points of readiest contact with the idea of the whole towards

the middle. Ultimately any part will be connected with the idea of the whole. Any pause in the series which allows either the idea of the whole to be revived or gives more time for impression, will help the memory of the neighbouring parts.

In any series associations are formed not only between the successive members (+1), but also between one member and the previous (−1) or remotely successive members (+2, +3, &c.). The following figures represent the relative strength of these associations:

−2,	−1,	+1,	+2,	+3,	+4	.	.	+7
15,	36,	100,	32,	21,	17	.	.	10

These retro-active and remote associations do not gain strength so rapidly on repetition as does the chief association (+1) and they lose it more quickly.

Associations leading from different cues towards the same end support each other when they are revived together, while associations leading from one point in different directions inhibit or check one another under these circumstances. This rivalry is specially great when an association *a*—*c* is being formed alongside an already strong association *a*—*b*. The very learning of *a*—*c* tends to revive *a*—*b* and to make it stronger.

Stronger associations are formed by a given number of repetitions when these are distributed over a period of time than when they are all done at one sitting. Thus for a total of 24 repetitions in each case it was found that 3 days of 8, 6 days of 4, and 12 days of 2 repetitions each gave for one person respectively the total numbers of scores: 18, 39, 53, and for another person: 7, 31, 55; the average recall-time was also shorter with the greater distribution. The advantage of distribution is evidently considerable. It is also evident that associations do not lose strength in proportion to the lapse of time, else we should forget everything completely after sufficient time. We all know that many memories are hardly affected by a lapse of time, after the first rush of forgetting has passed.

Associations lose strength at first rapidly, then slowly, and then hardly any more. An old association of a given strength provides a much better basis for relearning than does a younger association of the same strength. The young association is not so well consolidated as is the old one, although the new one may be more effective. The increase of repetitions of the old association has not to be spent in consolidation, but all goes to increase associative effectiveness.

For this reason, also, the learning of any matter has not so harmful an effect on the memory of what has been learned some time before, as it has on what has just been learnt. A new task following close upon another seems to check and destroy considerably the memory of the first. The two tasks need not be quite similar. The close examination of three pictures immediately after the learning of a series of syllables may reduce the efficiency of the memory by as much as a half and also make it slower.

Facts such as these enable us to form rules for the economy of memory work, so that we can get the greatest efficiency, speed of recall, and endurance out of any given number of repetitions. To this end we should be careful not to admit any mistakes or faults into the first few repetitions, which are more effective than the following. We should avoid learning anything wrong, because wrong methods and associations are very hard to eradicate, especially if they are already strong before correction begins. By learning things as a whole whenever possible and not piecemeal, we may avoid forming rival and ultimately useless associations. The form of practice in memory should be as like the final goal of memorising as possible. Too long series of pieces should not be learnt as one, especially if the matter learnt is unfamiliar and rather meaningless, because a long series demands an excessive number of repetitions; the large whole should be broken into parts. Repetitions should be distributed and a sufficient pause should be introduced between tasks that form separate units. One task should not be crowded

upon another. While learning we should vigorously will to learn so as to devote as much energy as possible to the formation of associations and to keep it from scattering itself upon other things, and we should thereafter trust our memories to work well and correctly.

In the preceding we have considered memory from its purely mechanical aspect, as consisting of units combined into groups by associations of greater or less strength. But in the learning of sensible material we find that all sorts of connections other than mere associations enter into learning and help it enormously. These are the integrative connections with which we were previously engaged, and which extend beyond the primitive forms of perception into the spheres of conception, thinking, reasoning, feeling, and emotion. A poem is not a mere sequence of words. It is divided into regular portions by lines or similar divisions, each end of which may be marked and so connected with another by rhyme. Each of these portions consists of a number of rhythmical parts. A set of lines may form a verse. The meanings of the phrases and sentences form natural units and they all join to form a single unity, in which there may be neat and pleasing apposition and contrast of ideas of time, of place, of purpose, of feeling, of beauty, and of many other appreciable characters. The parts are meant to fit together into an imperishable and unforgettable unity. So a mere group of numbers may also form a significant unity and be recognised as such, *e.g.* $625 = 25^2$, 365 = the number of days in the year.

These groups are commonly known as complexes, and it is important to consider memory in relation to them specially. They seem to be the means of all the more elaborate developments of memory. Professor G. E. Müller has shown that complexes were used very frequently by Dr. Rückle, whose memory for numbers he has carefully studied and has proved to be considerably greater than any hitherto recorded. In the tests that were made, Dr. Rückle was able to

memorise series of 20, 42, 60, 90, 102, and 204 figures in 17, 48, 89, 149, 259 seconds and 18 minutes respectively, while his rate of recall was some three figures a second, or in the two longest series two figures a second. Each group of three or six figures was apprehended as a familiar unit, possessing well-known properties or characteristics or related to another similar group in some definite way. For example, $624 = 25^2 - 1$, $429 = 3 \times 11 \times 13$ (all prime numbers), 528 was familiar in its square, 103,141 is like a familiar number 103,841, $451,697 = 11 \times 41(451), 17 \times 41(697)$, &c. The series of these groups was learnt specially and usually by other than visual methods by Dr. Rückle.

By these means the long series was reduced to a short series of groups, and each of these was attached to some well-formed association reasonably grounded in the numbers shown. Complexes may also be reduced to a skeleton of important parts from which the whole can be easily revived. The amount to be learnt is thereby much reduced and the work of learning becomes easier. Dr. Rückle believed that the greatest economy of effort depended on a proper division of the whole matter to be learnt, so that the size of the parts should be properly balanced against their number in the series. Too small parts give too long a series of parts. Too large parts are too hard to memorise and to reconstruct on recalling. It is one of the merits of this style of memorising that it can never be passive; the learner must himself seek the basis of his reduction of the raw material to be learnt in the natural connections of that material; he must think actively both while learning and while recalling, for there he has to find natural complexes and here he has to reconstruct them. When imagery is used in the process of reconstruction, it is found to be at first fragmentary, when only the cue to the complex or its essential parts recur; it grows clear as these beginnings gradually revive each part successively or the whole at once.

These processes are of the greatest importance for the remembering of complex subjects like mathematics,

sciences, an other groups of facts and details arranged on their merits into systems. Facts, connections, relations, laws, and proofs made familiar in the elementary study of these subjects recur continually, and can be inserted in their proper places without being re-proved or even completely revived. So they help to construct larger units, and these again form still larger units. For this reason any higher branch of mathematics or of many sciences is largely unintelligible to the studious beginner, because he has not yet developed the intricate complexes required. In certain other studies, *e.g.* descriptive parts of biology and history, a study of one part of the field is sufficient guide to most other parts, because the whole tends rather to be more homogeneous and level than to be an ever higher structure. Yet even in these subjects the matter of study is eagerly converted into large systematic complexes wherever that is possible. Such extraordinary memories for prose or poetry do not occur, as they do for numbers, mathematics, sciences, and the like, because in the former the development of complexes is largely limited to words and phrases. Lines, verses, and pages are not repeated, recalled, or implied, as are the results of elementary study in the higher work of mathematics and the sciences.

In our everyday life we also form many complexes, which are often recalled momentarily without the explicit recognition of any or many of their parts. Thus even the imagery revived with these ideas of complexes may be very fragmentary. It may often be just what is essentially characteristic of the whole object or complex of objects or what has been important to the thinker at some period of his mental occupation therewith. A friend may be visualised as a mere cast of feature, a gesture, an attitude. A song or a speech may be echoed by a special phrase, a top note, a name or word reiterated, or as a few themes. The memory may, however, become much fuller if we pursue it to its limits.

The formation of complex motor habits proceeds in a similar manner. At first we toil laboriously at the

elements, learning each letter, each sound or syllable, each finger-movement. Soon these combine into words and complex movements, which can be brought about by one impulse, until finally we can discharge a phrase, our signature, a sentence, a passage, or any complicated action with a single fiat of the will. It is well known that the intrusion of special attention to details into a familiar action of habit endangers the success of the whole action. Attention then tends to plunge a part of the whole into a new mental setting, whereby impulses get new outlets and more time is devoted to one stage of action than is compatible with the stream of the whole action. Inco-ordination is almost inevitable, These motor trains involve little or no imagery or thought relating to the action about to take place. Feelings of satisfaction are, of course, constantly aroused by the outcome of the action, as in any well-played game, like tennis, based upon high practice. In the recitation of poetry or in musical and other artistic performances, a certain amount of anticipatory realisation and enjoyment of the action and its results is more natural; but even here a case is on record where a pianist had no auditory or other images of what he was about to play and could, therefore, only enjoy it and realise it in so far as he had already just played it. As there is no inherent and necessary distinction between sensation and imagery, it is of course absurd to believe that in will or expectation we must always have mental images of what is about to happen. On the contrary, our thinking, willing, and expecting may be based on sensation and immediate perception, and, in fact, in highly practised habits they very often are so.

It is upon lines like these that we must approach the study of all those mental states and processes that lie beyond primitive perception and make up knowing, imagining, and thinking. But we cannot follow them further here.

CHAPTER VI

FEELING

THERE are several reasons which make it advisable to treat the feelings separately. These will emerge as we proceed. It is, above all, important to have fixed some standards in other parts of experience which will serve as a guide to the study of feeling.

The classification of the feelings as mental states is very much in debate. To some they seem most like sensations, and are considered to be either a special kind of visceral or other vague bodily sensations, or sensations which indicate, not the immediate effect of a stimulus upon the sense-organs of the skin, eye, or ear, but the manner in which this effect departs from what is most usual or natural in the eye or ear or the nerves connected with them. The feelings would then depend on a kind of *nervus nervorum*, which senses the senses, or, in fact, all experience. But feelings of pleasure and displeasure do not look like sensations in their general character. They do not seem to possess all the attributes of sensation except in so far as they are attached to and qualify sensations. Those who classify them as sensations have, therefore, to make a forced discovery in them of characters of extensity and localisation. Besides, the isolated occurrence of feelings has not been convincingly established. In the face of these difficulties it is evident that the assumption of inner sense-organs rests purely upon speculation.

The weakness or failure of all attempts to reduce feeling to sensation or to classify it as such have led to the generally accepted view that feeling is a special

kind of elementary experience. As such it seems to justify its peculiarity by the possession of a group of attributes which are not identical with those of sensation. But if feeling is an element, we should expect it to occur alone, which it does not seem to do. It is always referred and attached to other experiences, which may be of almost any kinds. Moreover, it is hard to see why feeling should be able to exist without certain attributes which seem essential to the existence of many kinds of sensations. If we said their absence from feeling is accidental and unimportant, it would then be impossible to attach any importance to the demonstration of the presence of attributes in certain sensations which seem to lack these attributes. Thereby would disappear the only really psychological reason for classifying sensations as a special group of experiences, and with it, of course, every introspective reason for grouping states of mind, feeling included, into classes at all. Such a conclusion would mean sheer chaos.

No serious modern attempt has been made to classify feeling with the cognitive states. We do not know anything by means of feeling; feeling does not mean anything. It is always considered unrepresentative, the mere consciousness of a state, to be taken at its face value. Those who interpret all experience in terms of knowledge, tend therefore either to ignore it or to consider it as the only indication we have of how the self is affected by the world around it. In happiness or in misery the self merely suffers and is all but dumb.

The reasons given in the last paragraph but one justify the view that feeling is a derived state. A comparison of its characteristics with those of a state that is clearly derived will serve to confirm this view. Such a state is motion. Motion is not peculiar to any one sense, but is found in all the senses where the attribute of order, from which it is derived, occurs. It is attached and refers to the sensations of which it forms the integration. It is always actual; in other words, its integration is unaffected by the mode of origin of the integrating sensations, which lead us afterwards to

distinguish between sensation and imagery. It can be characterised introspectively only as a development of the attribute which forms the basis of its integration —order; it does not possess of itself any localisation, extensity, or intensity, except in so far as the sensations which it integrates show these attributes. The introspective account of it which can be given is therefore very limited. We recognise and name motion easily, but we can indicate or describe it further only by reference to the object which moved or the sensations by which we are aware of that object. As an integrated state, motion presupposes more than one integrating sensation; it is really the unity of these in respect of their differences in order within certain degrees.

All the preceding points hold good for feeling. It can be produced by all kinds of experiences, and it is attached and refers to them. It is always actual, no matter how the sensations or other experiences which go to form it are evoked, directly or indirectly. It is much less efficiently produced by incomplete than by complete revival, if indeed it is ever produced by the former; we cannot yet be certain, but it seems at least plausible and probable that feeling is produced only so far as its basis is complete. It lies outside the range of representative experiences. The introspective characterisation of feeling is limited to "quality"—pleasantness or unpleasantness—and to intensity; other attributes it seems to have only in so far as it is referred to experiences that have them. Finally, it is never evoked by a single experience, but always presupposes more than one.

This last aspect of feeling is perhaps disputable only in the case of the simple tastes and smells, which seem to evoke feeling single-handed. But even here, although there is much agreement as to pleasantness and unpleasantness, we find that a liking for bitter, sour, and salty tastes of moderate strength can be acquired. What has changed to account for the change of feeling? It is impossible to say definitely at present. There is evidence of a rather uncertain kind which

suggests that certain sensations from the digestive channels and from the viscera account for the change. The strongest kinds of feelings and emotions bring visceral and kindred sensations to the attention. Their prominence accounts for the theory of emotion propounded by W. James and C. Lange, which maintains that the sensations excited reflexly in the viscera and elsewhere by the action of any object upon the senses and nerves constitute the emotion proper. "Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run. . . . The more rational statement is that we feel sorry because we cry, and afraid because we tremble. . . . Without the bodily states following on the perception, the latter would be purely cognitive in form, pale, colourless, destitute of emotional warmth." [1]

But such a view belies experience as no psychological theory can be permitted to do. The normal process is certainly to cry because we are sorry. The theory also omits to show how we know what we are sorry about. Suppose a mother, on reading the school reports of her two sons at one time finds that the one has distinguished, the other disgraced himself. She might be sorry and glad together; but how should she be aware that she was sorry for the disgrace and glad for the success. Suppose the crying set up by the bad report should begin just after the reading of the good one! As it stands, however, the theory may contain much truth. It is, indeed, difficult to explain preferential emotional reactions otherwise than by assuming that they are based ultimately upon reflex nervous mechanisms; for they seem often to be independent of past experience and typical of a species of animals. It is probable that the changes wrought in experience by these reflex mechanisms, *e.g.* the ensuing visceral sensations, are essential to the occurrence of emotional states; but no high degree of reaction is necessarily involved in them. Thus the emotional state which results from them is usually felt before the bodily reactions are

[1] James, *Principles of Psychology*, 1891, ii. p. 459 f.

intense enough to call attention to themselves, if they do become so intense at all. Usually they do not. Nor do we usually become separately aware of our visceral sensations, if they enter as a constituent part into emotion. We are not likely, therefore, to think them the cause of our sorrow. The pale emotion is the fear that is caused by noticing the trembling or the sorrow that mere weeping causes. Common sense calls such emotions silly. Besides, it is familiar teaching in physiology that several different central neural mechanisms may produce the same muscular or glandular activity; they may have the same "final common path." Uncontrollable mirth, grief, anger, and injured pride may all end in copious tears. The same emotion should be produced in all these cases, unless it is intimately bound up with complex awareness of the actor's foolery in the first case and of the pain or loss in the others.

No doubt the processes involved in the occurrence of feelings and emotions are very subtle, very complex, and very difficult to analyse. We must, however, acknowledge that feeling is better considered as a complex state resulting from the integration of various experiences, frequently sensations, of which some are as yet undetermined; by this integration feeling acquires a connection with and reference in all cases to objects or sensations, which, as we say, excite the feeling and, in exceptional cases, to the felt state of the self or person, more especially the viscera and internal conditions and reactions of the body generally. We find a parallel to this in the integration of tactual with articular sensations to give a differentiation of the localisation of one and the same tactual point (*e.g.* the finger-tip) at different positions in space. The resulting differentiation is usually referred predominantly to the tactual component; the articular component is, of course, effectively present, but it only becomes separately clear sometimes. Feeling, moreover, does not add to the objective side of experience, as it would if it were based upon sensations directly evoked by stimulation of any one set of sense-organs. It expresses rather the compatibility be-

tween the objective and the subjective sides of experience, between the world and the self. Just as little does the articular sensation add to the tactual experience as such, which remains the same even if the former changes. Every theory of feeling must do full justice to all its characteristics.

Elaborate attempts have been made to register graphically the effects in the body produced by or accompanying feelings, *e.g.* changes in the rate and amplitude of the pulse, changes in the blood pressure as indicated by the changing volume of the arms, changes in the manner of pectoral or abdominal breathing, changes in the state of contraction of special groups of muscles, &c. But little has been gained by these researches on the whole.

More fruitful is the investigation of the dependence of feelings upon the sensational nature and arrangement of its object and the like. So the varying pleasantness of colours, tones, tastes, and smells can be established, as also the most pleasant grouping of simultaneous or successive tones in harmonies, melodies, and progressions, the pleasantest tempos, rhythms, and keys for these, the pleasantest grouping of colours, of lines, of surfaces, of figures, and so on. These investigations constitute the object of experimental æsthetics.

Of the methods, the simplest is that of choice, wherein an observer chooses from amongst a number of forms the one he likes best, next best, &c., second least, and least. This method is followed generally by the spectator in a gallery. Or a given number of forms may be compared systematically with one another, so as to give each an equal opportunity of being tested. We proceed much in this way when we select one of a number of forms of Christmas card from a catalogue. Or the observer may have to produce the form he thinks most pleasant. A lady plans a dress and the creative artist works in this manner. A certain number of possibilities are imagined or partially realised in sketches, and these are then compared with one another fairly exhaustively; in so doing the observer may bring the

processes of choice and comparison of pairs into operation. But not all the possibilities are at any time realised or compared. These and other methods in general popular use have been adopted and moulded to more exact and complete form for use in experimental æsthetics.

These two large fields of work represent the double basis of feeling in object and person. A complete understanding of feeling may be expected to follow the thorough investigation of both fields in relation to one another.

CHAPTER VII

ACTION

THE study of action is exceedingly difficult and complicated. The problems involved in it may be divided into three main classes: (1) those relating to the connection between mind and body; (2) those involved in the natural classification of forms of action; (3) those concerning the reality of effort and the degree of its predominance over other conditions of action. Each of these three groups we shall consider briefly.

I. The nature of the relation between body and mind can only be settled by a general philosophical consideration of all the inductive results of all the special sciences of body and of mind. Special devotion to the results of any one science, the science of knowledge or epistemology, psychology, or physiology, is apt to give theories which fail to do justice to the results of other sciences. It is not surprising that in the flush of early success, while the prevailing and popular psychology considered the mind to consist wholly of sensations in juxtaposition and images or revived sensations bound into groups by association, physiology arrogated to itself the last word on the subject. But in face of the study of the physiology of complex sensory states, *e.g.* binocular vision, some of the best scientists are now more cautious and are willing to grant to the mind a certain amount of autonomy. Mental states are doubtless dependent upon the activity of the nervous system, but they are not mere functions or appendages of its parts. The argument from the law of the conservation of energy, which has been brought to show that mind can play no effective part in the process of causation, but is only an

inert addition which lies aside from the main stream of causes—an epiphenomenon—is both arbitrary and insufficient. A leakage of energy from body to mind, and therefore a seeming departure from the law of conservation, could be verified only if mind were separable from body, which is not the case. Hence any measurement of the energy of body must at the same time render patent and also measure the energy of mind. Every view which reduces mind to a mere inert series of phenomena, is belied by the experience and conviction of everyone and is useless and contrary to psychological knowledge. The conviction of the reality of mental activity and effort is so strong in all men that any theory which declared it illusory would be liable to be cast aside at any time, no matter what might otherwise be said in its favour. Such a procedure may seem irrational, but it is the source of many scientific revolutions.

There have been at all times thinkers who believed that the whole world, including nature, is built after the plan indicated in conscious experience. This view is certainly more plausible than the preceding; for while we are so acquainted with mind as to know that the materialistic interpretation of it is inept, no one knows anything about the inner nature of the ultimate constituents of matter. Consequently they may really be of the same stuff as consciousness. But as the study of forms of arrangement and combination is the chief object of the natural sciences, no contribution to general theory can be made by psychology until it has mastered the study of the forms of arrangement and combination of the elements of mind and has shown them to be compatible with those of the elements of inanimate or animate things. That is indeed a very far prospect!

Theories of the nature of the relation between body and mind based upon epistemology or the study of the process of knowing itself must necessarily be very superficial and incomplete, even if they are possible and probable, as far as they go. For so general theories can do nothing to resolve in detail the crass and abrupt

divisions we find between the inanimate and animate, the merely animate and the psychophysical organism, the barest mind and the conscious, thinking personality.

We must, therefore, in psychology be content for the present with a principle for the guidance of work, which enjoins a search for the bodily parts and functions on which mental states are immediately dependent. The knowledge we have, either of body or of mind, is much too meagre to allow us to hazard an opinion as to whether mind interacts with body or only accompanies it in parallel.

II. The classification of the forms of action may be based upon their physiological or upon their psychological nature. When the one side is apparently absent or very obscure, the main guidance will be given by a study of the other. Thus in reflex action mind is either totally absent or only present in the barest rudiment; this rudiment can in no way partake of memory or of foresight, and is therefore unknowable by introspection. What special form of neural activity is responsible for voluntary action and thinking is entirely unknown; the study of these will, therefore, be mainly psychological. Neither line of study, however, can be based upon general impressions, but must be as exact as possible under the circumstances. In this respect psychological classification has been very deficient; only recently has strict analysis and experiment begun to replace the rough and ready results of general impressions.

The simplest form of action—reflex action—involves stimulation of a receiving (sense-) organ, the passage of this stimulation over a series of nervous units (neurons) to a muscle, which is thereby made to contract or relax. The stimulation of the receptor is often very simple, if not one of the simplest possible. Where it is complex, exact study calls for its analysis into elements. In psychology we effect a parallel to this work in the study of the elements of sensation. But neither in this case nor in any case in which a movement simply follows

and depends upon a conscious state, are we called upon to explain the connection between the two. The need for psychological theory arises only where a movement is consciously willed and is brought about by willing. Reflex action includes all actions that are typical of a species, that are dependent upon the stimulation of sense-organs or the immediate products thereof in a nervous centre, and that are inherited complete without involving any personal acquisition, although a certain amount of practice may be necessary for perfect action.

In distinction from reflexes, the other and more complex forms of action are at least partly peculiar to the individual; they are the coalescent resultant of at least two different systems of stimulation; they are based upon more or less rudimentary inherited structures, which are often very much extended by personal acquisition through trial and error and similar processes; and they, therefore, in all cases involve some degree of consciousness. It is impossible to give any satisfactory classification of them yet. The following must be considered only as a tentative sketch which aims at showing mainly the method of division to be followed.

This method is based upon the most distinctive feature of these forms of action—their twofold systems of conditions. In the preceding pages we have traced the main lines of integration of the elements of experience. Since action always involves an object of action, we find all degrees of complication in this object, from that of the simplest sensation in reflex action to that of the most complex and remote object of speculation in the voluntary actions of thinking. A similar progressive complication is found in the secondary systems of stimulation characteristic of the higher forms of action. These will, therefore, best be arranged according to the degree of complication of this secondary system. At present, however, only the main stages of this development can be indicated.

Certain forms of instinctive action—feeding, drinking, resting, mating, &c.—seem to stand nearest to the reflexes. In these cases the secondary stimulus is a

fairly simple sensory state emanating from sense-organs, well termed proprioceptive, situated within the animal's body and indicating a certain state of that body. Although we usually speak of these stimulations as negative, as wants or needs, they are, of course, really positive excitations, additions both to physiological process and to experience. They are hunger, thirst, fatigue, and sexual appetite. It is of advantage to an animal to feed and drink, not whenever food or drink is obtainable, but only when it is needed; hence the necessity for a double system of stimulative conditions.

Under natural circumstances, however, the secondary stimulus will usually arise first. An animal becomes hungry or feels appetite when no food is immediately obtainable. As we know from experience, hunger produces a form of wakefulness and muscular restlessness which, in a primitive form, *e.g.* in a fish, would simply cause the hungry animal to move about and so to increase its chances of meeting with suitable food. When it is in contact with the food it will then swallow it. Under the pressure of this secondary stimulus, which will become the more intense the longer food is absent, muscular activity will become more vigorous and more extensive, and food will be attacked faster, eaten faster and more abundantly. Thus any obstruction or delay to the satisfaction of these primitive instincts seems to excite an effort which gives the semblance of will. All those actions of which the secondary stimulus is a fairly simple proprioceptive sensory state will, therefore, form one class. But we must not add to them all those actions which are heralded by a need, *e.g.* (according to some writers) the religious "instinct." These should go to form a special group according to the special character of the needs involved in them.

The mental states accompanying instinctive action may be considered as a threefold product, resulting from the objective sensations, the proprioceptive sensations, and the pleasurable experiences of the action itself—the satisfaction of need. The object of the instinct will accordingly appeal and appear differently

when the need is felt and when it is not felt; its presence will excite pleasure, its removal displeasure; if the food is palatable the pleasure will be greatly increased, if it be unpalatable it will be rejected as unpleasant. All these actions, of course, are inexplicable in terms of the experiences involved in them; we must simply consider them as based upon partial, inherited reflexes, the grouping and linkage of which are managed, at least for us, by the grouping and linkage of experiences.

Many forms of apparently instinctive actions are very complex indeed, *e.g.* the process of nest-building among birds, the provision of proper food and shelter for eggs among solitary wasps and other insects. No one dare claim to understand these things fully; they are so fixed and so independent of practice that they seem to be mechanical; yet they are so intricate that they seem necessarily to involve intelligent guidance. We are the more at a loss here, as we do not find in our own conduct any one complex form of action common to all men and inherited complete.

But we are better acquainted with those forms of instinctive action which involve much "learning by experience." There is good reason to believe that nothing is learned by trial and error, unless it be under the stress of instinctive impulse and need. Most animals learn nothing by imitation or by being put through an action passively. The integrations of their experiences contain no remote references except by way of impulses, which are, of course, extra-mental machinery and are not conscious references at all. When one cat jumps upon a wall another may follow, because there is in the cat a jump-up impulse, which the sight of a fellow up there can awaken. But if one cat gets out of a box by pulling a string, its success will find no string-pulling impulse provided in the untrained cat. Similarly, passive handling is only training for impulses towards passive handling, not for impulses to make the movement oneself. To make an animal learn a trick, therefore, it is well to arrange things so that, when the stress of some common instinctive need like hunger

arises or has arisen, there will be an easy chance of its doing the required action by accident, of its own inchoate impulse, and thereby satisfying its need. If the chance is not easy, or if its doing is not means to satisfaction of need, the trick will not be learnt.

Experiment has shown that it is highly unlikely that animals learn by association from the moment of need forwards to the means and moment of satisfaction; for in learning difficult tricks the amount of random effort wasted before the average chance finds the trick action is so great and so absolutely irregular as to be out of all proportion and resemblance to the final, easy, simple action. The course of learning is rather the reverse, from the means and moment of satisfaction backwards in a lengthening chain to the moment of need. Though acquired backwards, this chain is, of course, always traversed forwards. The links given to start with are the impulses which lead an animal, *e.g.*, from an opened box to the waiting food. If the box is very small and can be opened by a downward movement of the paw, a cat will readily learn to get out, because the chances of its making the movement at the right time and place are great. The cat has only to extend the given links by the addition of the impulse to the paw, and this alone can immediately precede them if the cat is to get out of the box at all. If the box be increased in size, the number of possible actions and situations to be run through on the average, before success arrives, is enormously increased, and the learner has nothing to guide it forwards through this maze. As the final chain of impulses common to all successful efforts lengthens backwards, the smaller will be the maze of chances to be traversed before the cat hits upon the nearer end of the chain which leads directly to the trick action; the shorter the chain, the longer will the cat take to pick up the nearer end. When it is complete, the animal simply walks over on a continuous chain of impulses leading from the moment of need to the means and moment of satisfaction. The cement of the whole chain we must suppose to be integrative

coalescence of impulses with the inborn rudiment of action whereby the need is satisfied. It is not necessary thereby to interpret satisfaction merely as pleasure; it certainly means also, *e.g.*, the simple action of swallowing, which is after all the essence of the whole action of feeding.

Thus a kitten has no innate knowledge of a mouse, neither by sight nor smell. It has an innate tendency to run after small moving things. If these, when caught, behave as mice do and are palatable, then the moment occurs in which smell, taste, and sight can join hands to make the kitten afterwards "know" the moving, smelling object as something to be watched and grabbed.

We cannot pause here to justify the classification of "play" with the instincts extended by learning, or to discuss the problems of imitation, but must pass abruptly to the consideration of a very different class of actions—the emotions.

In these the secondary stimulative system is of the integrative order of the feelings (*vide* chap. vi.). It therefore requires the co-operation of exteroceptive and proprioceptive components, and, on its first appearance at least, cannot arise before the occurrence of the former, so that the term "need" is inapplicable to the emotional state. In later experience, however, emotional action may involve much learning by experience, as when the thief—child or dog—surprised in the act by the sounds of a footstep, shows fear and hides. Once the emotional state is aroused, all the subsequent behaviour of the individual is a resultant of that state and of the changes in surrounding circumstances, especially in the object of the emotion, which prompt action. Practically everything of an intimate, decisive nature has yet to be done for the true elucidation of the physiology and psychology of the emotions, of their classification, and of their forms of combination and complication.

The voluntary actions form the last great class of actions to be developed, probably only in man. For

them research has as yet distinguished only one generic secondary system of conditions, the instruction, preparation, or so-called determining tendency. This takes the form of instruction, intention, command, wish, question, suggestion, or idea of relation between object and action (movement or end in thought). Thus in the question: "What is the capital of France?" France is the object, and the relation or instruction is: "What is the capital of." The answer, in other words, is that which is to France what the capital city is to any country. The command, "Get up!" means that a certain movement natural to the human body is to be made real in the person of the individual addressed. The command, "Turn inside out!" is therefore impossible. Only that is possible to the will which is made possible by other forms of action, especially by learning by experience. But much more mentality is obviously required therefor than is involved in mere learning by experience: not only associative habit, but also the integration and incomplete redintegration of memory, conception, thought, and reasoning. Hence there are doubtless innumerable varieties of voluntary action yet to be established by distinction of the different kinds of instruction. This instruction shares the character of a product of integration revived by a part of its integrative basis or by its associative connections, and therefore capable of reviving any or a certain part of its integrative basis. It is only upon this view that we can explain why the instruction "write" causes an act of writing to follow the hearing of the word "house" and not any one of the thousand other sequences of the experience of that word. The two conditions given—the word "house" and the command "write"—being integratively compatible, fuse to make one redintegrative consequence necessary. Otherwise the strongest association aroused by the word "house" would win the day. And where the mind of the individual contains several redintegrative issues compatible with a command, *e.g.* "name an animal," it is in fact found that of these the strongest is revived. It has

also been proved experimentally that errors arise when a non-compatible issue is so strongly associated with one or other of the conditions of action—object or instruction—or so ready to offer itself, that these conditions together are too weak to arouse a correct action more quickly and before any other. In general, all error or departure from truth is an issue to conditions given in conscious experience which do not of themselves integratively involve that issue. The actual issue has been prompted by conditions whose presence or effectiveness was not observed or which are other than those to which the issue was consciously referred.

III. The third group of problems of action is concerned with the reality of effort and the degree of its predominance over other conditions of action. This question has always formed and will always form the keystone of all human knowledge and speculation. However grand the structure, it will never finally be safe till it is finished with that magnificent jewel that delights the eyes of all men and never wearies—the reality of effort. Only in ourselves do we feel the pulse of the world. The vast universe around us has to be so contracted and dulled to meet our feeble eyes that, whatever it really be, it must appear purely routine and mechanical. Our mind conceives only what is true of whole classes of things—living or lifeless. Individuality is beyond our ken except in the intimate relationships of human life. We should all ridicule the idea that our efforts, our striving, our attention, are mere signs of the mental activity unfolding in us at any moment, as hunger is, in a manner, a mere sign of want of food. We are all sure that life would lose its worth did we not really strive but only seem to strive.

The study of instinct persuades many men that it is a blind activity without knowledge and foresight, vigorous only as is the impulsion exerted upon it from behind. But to that the response may be made that both the external and the introspective study of voluntary action show it to be similarly determined by given

conditions—object and instruction. Hence from others comes the refrain that, far from being mechanical, instinct is for that very reason the partner of all the spontaneity of will. To the outside view they appear alike; to the inside view, as far as we can tell from ourselves, they feel alike; to theory their construction is alike. Where, then, is the difference?

Difference there is certainly in the experiences involved in each, whether in the awareness of its object or in the awareness of its preparatory states—proprioceptive, emotional, and instructive. These grow in subtlety, extensiveness, and inclusiveness. But our knowledge will not yet allow us to deny all worth to actions other than voluntary, or to call them purely mechanical. There are many considerations which urge us to believe that even these are a form of striving. Possibly all conscious life shares in striving in various degrees. We are more acutely aware of it in voluntary action. There we certainly do give or withhold our assent, and in all the large tasks of life much effort and much persistent application is necessary to their completion. Probably we yet know too little intimately about mind to speak securely. We must examine and compare experiences of different levels until we fully justify our anticipatory beliefs or correct them. Something has been done, but much remains to be done. The psychology of the future will surely be as grand and impressive a science as any that have risen from little, despised beginnings to their present splendour.

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(1) Sir Francis Galton, *Inquiries into Human Faculty.* 1883. Dent & Co.'s "Everyman's Library."

(2) W. McDougall, *Physiological Psychology.* Dent & Co.'s "Temple Primers." 1905.

(3) C. S. Myers, *An Introduction to Experimental Psychology.* Cambridge University Press, "Manuals of Science and Literature." 1911

(4) W. McDougall, *Psychology, The Study of Behaviour.* Williams & Norgate's "Home University Library." 1912

The student should make no delay in beginning to observe experience and conduct under experimental conditions. Systematic work with very simple materials can be most instructive, if good methods are followed and if introspective observation is zealously cultivated. A simple and useful introduction to general experimental study of the senses will be found in:

(5) J. A. Dell, *The Gateways of Knowledge.* Cambridge University Press, "Nature Study Series." 1912.

Ampler guidance is given in the larger work of

(6) C. S. Myers, *Text-book of Experimental Psychology with Laboratory Exercises.* Cambridge University Press. 2nd ed. 1911.

The advantage of a course of instruction and exercise in experimental psychology, such as is now offered by most of our British universities, is very great indeed; without it even the most intelligent student is apt to acquire schematic and illusory notions regarding ex-

perience. In this respect psychology makes the same demands upon the learner as do the natural sciences. Careful attention should always be given to the general problems of experience and conduct, which the solitary student will find well expounded by

(7) G. F. Stout, *A Manual of Psychology*. University Correspondence College Press. 2nd ed. 1913.

The student may then pass to the study of larger works in any department of psychology—introspective, statistical, animal, infantile, social, religious, or abnormal, —ready to understand and criticise their methods, basis, and outlook.

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